10/24/91

BAY AREA
'91 CLEAN AIR PLAN

VOLUME III

APPENDIX G
STATIONARY SOURCE CONTROL MEASURE DESCRIPTIONS

October 1991

Prepared by
Bay Area Air Quality Management District
in cooperation with
Metropolitan Transportation Commission and
Association of Bay Area Governments

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TABLE OF CONTENTS

(CONTINUED)

TABLE OF CONTENTS

APPENDIX G

Stationary Source Control Measure Descriptions

INTRODUCTION

This document contains descriptions of control measures which are included in the Bay Area '91 Clean Air Plan (CAP). These measures are listed in the CAP in Table 2, "1991 Clean Air Plan Stationary Source Control Measures." This document supersedes an earlier draft, "Bay Area 1991 Clean Air Plan -- Control Measure Descriptions," dated June 25, 1991.

These control measures are primarily directed at reducing the emissions of reactive hydrocarbons (RHC) and nitrogen oxides (NOx), which are precursors to the photochemical formation of ozone. The measures in this document are primarily stationary source RHC and NOx control measures, which are being considered for a planning horizon extending through about the year 2000. All but two of these measures (A17 and B4) will be implemented by the BAAQMD. In addition to the stationary source measures, two motor vehicle measures that would be implemented by the BAAQMD (H1 and H3) have also been included in this document. These mobile source measures would complement the primary mobile source control programs (i.e. the Air Resources Board's Mobile Source Control Program and the Transportation Control Measure Plan).

The stationary source control measures have been divided into six subgroups: (A) surface coating and solvent use, (B) fuels/organic liquids storage and distribution, (C) refinery and chemical plant processes, (D) combustion of fuels, (E) other industrial/commercial processes, and (F) other stationary source control measures. Two additional groups of measures are included: (G) intermittent control measures, and (H) motor vehicle controls.

The control measures included in this document are measures considered worthy of detailed evaluation. Ideas for control measures have been taken from a number of sources, including BAAQMD staff suggestions and air quality plans from other ozone nonattainment areas in California. Measures that have already been adopted by the BAAQMD or are planned for adoption by ARB or EPA (e.g. emission standards for off-road vehicles) are not included for detailed consideration.

The type of information compiled for each candidate control measure is described below. As control measures go through the rulemaking process, more detailed information will be developed, that may differ from the information presented in these descriptions.

Background

This section describes the specific sources of emissions that would be affected by the control measure and the major types of pollutants (e.g. RHC or NOx) that would be reduced. Where possible, the number of facilities that would be affected by the proposed measure are given.

Regulatory History

In this section, past and present regulatory controls for the affected sources are identified. Information on whether the measure is being applied or is under development elsewhere is also presented.

Emissions Subject to Control

The source category or categories affected by the control measure are identified, and the projected "uncontrolled" emissions are shown for the years 1994, 1997, and 2000. The emission reductions from implementation of already adopted control measures are reflected in these emission projections. The emission estimates given are for an average summer day in units of tons per day (TPD), unless otherwise indicated.

Proposed Method of Control

The proposed method and level of control are described in this section for each control option being considered. If specific technologies are involved, their technical feasibility is described and examples of any current applications are given.

Emission Reductions Expected

Based on the expected level of control specified in the previous section, potential emission reductions are calculated for the years 1994, 1996, and 2000. The calculations assume the measure is fully implemented in the specified year in the absence of other competing control measures not currently adopted. In many cases, ranges of emission reductions are provided to address the uncertainty that exists in the estimates made.

It is important to note that the timing of control measure implementation will depend on the schedule established in the final Clean Air Plan adopted by the BAAQMD's Board of Directors. The scheduling of control measures is based on consideration of the measure's technological feasibility, cost-effectiveness, total emission reduction potential, public acceptability, enforceability, and any other factors deemed important (e.g. other environmental impacts).

Costs of Control

In this section, cost estimates for implementing the control measures are provided, if available. Costs may include capital costs (the one-time expense of purchasing pollution control equipment and other hardware) and annual operating and maintenance costs. An average cost-effectiveness estimate (i.e. cost per ton of pollutant reduced) is provided for affected sources, where possible. In some cases, cost-effectiveness estimates were taken from available information (EPA or ARB reports or other District attainment plans or rule development staff reports). In other cases, cost-effectiveness was calculated based on a discounted cash flow method using 1990 dollars.

Other Impacts

In this section, environmental, energy, and social impacts (positive and negative) associated with the implementation of the proposed measures are identified. Possible environmental impacts include health risks from toxic air pollutant emissions, water pollution, solid and/or hazardous waste generation, emissions of stratospheric ozone depleting substances and emissions of global warming compounds.

References

References that are directly cited or that are used to provide general background information are listed in this section.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

A. SURFACE COATING AND SOLVENT USE

CM# A1: IMPROVED ARCHITECTURAL COATINGS RULE

Background

This control measure would reduce RHC emissions from architectural coatings by lowering the VOC limits for some specialty coatings, and by removing the existing small container exemption.

Due to the small scale and intermittent nature of architectural coating operations, the installation of control equipment is not practical or cost-effective. Therefore, the regulatory focus continues to be to encourage coating reformulation to reduce the VOC content of coatings. Coating manufacturers are prohibited from manufacturing products which do not comply with specific VOC limits. In addition, end-users (i.e.. painting contractors and the general public) are prohibited from applying coatings which do not meet the VOC limits. It is extremely difficult to enforce architectural coating requirements from an end-user standpoint. However, by imposing limits on the manufacturers, non-complying coatings are generally not available to the end-users.

The availability of low VOC architectural coatings is dependent on the type of coating and desired coating characteristics. For example, flat and non-flat waterborne house paints are widely available with VOC contents well under the existing 250 grams per liter VOC limit. In contrast, many specialty coatings (e.g lacquers, wood preservatives) are available only in solvent-borne formulations which have much higher VOC contents.

Regulatory History

The District regulates RHC emissions from architectural coatings under Regulation 8, Rule 3, which was originally adopted in March of 1978. Rule 8-3 has been modified several times establishing increasingly more stringent VOC limits for architectural coatings. Currently, Section 302 limits the VOC content of general architectural coatings to 250 grams per liter. Section 304 contains individual VOC limits for a number of listed specialty coatings. On January 17, 1990, Section 304 was modified to include more stringent VOC limits with future effective dates in 1992 and 1994 for several of the specialty coatings. All coatings sold in containers having capacities of one liter (1.1 quart) or less are exempt from Rule 8-3.

The South Coast AQMD has adopted a control measure in their 1989 AQMP revision proposing to further reduce the VOC limits of architectural coatings and to eliminate the small container exemption (CM #88-A-8a).

Emissions Subject to Control

Inventory estimates are available for a wide variety of specific architectural coatings -- this control measure will affect only certain specialty coatings. The most notable architectural specialty coatings for which lower VOC standards are considered feasible are the clear wood finishes (i.e. lacquer, varnish, and shellac). The emissions from associated cleanup solvent categories should also be affected due to increased use of waterborne coatings; the emissions from cleanup solvent usage were not, however, included with this control measure in order to avoid overlap with CM #A18, "Substitute Solvents Used for Surface Preparation/Cleanup of Surface Coatings", which should provide more significant overall reductions in cleanup solvent emissions.

The emissions from architectural coatings sold in small containers have not been well established. Small containers were assumed to account for between 0.5 and 5 percent of the total solvent-based specialty coating emissions, depending on the coating type. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	3.44
1997	3.52
2000	3.60

Proposed Method of Control

This control measure will reduce the VOC limits for some architectural specialty coatings below the current standards. This will force coating manufacturers to continue reformulation and encourage the development of alternate technologies, such as the newly emerging reactive diluent technology. Reactive diluent coatings result in lower RHC emissions because most of the organic solvents chemically react to become part of the finished coating. Technological advancements made with flat and non-flat waterborne coatings also may be transferable to some of the specialty coating categories.

The South Coast AQMD estimated that reformulation with waterborne or low solvent technology will result in coatings with a VOC content of 300 to 400 grams per liter by the year 2000, and 150 to 300 grams per liter by the year 2010. These estimates are based on reformulation technology currently in use or under development in the architectural coating industry.

Emission Reductions Expected

In order to address uncertainty in the VOC levels that will be achievable for the coatings being considered, low and high emission reduction estimates were made. The level of control was calculated for each affected coating based on the difference between the current (or future effective) adopted VOC limit and an assumed 275 grams per liter VOC standard. The low emission reduction estimates, ranging from 21 to 50 percent depending on coating type, were made assuming that coating usage would remain constant on a volume of total coatings applied basis. The high emission reduction estimates, ranging from 32 to 75 percent depending on coating type, were made assuming that coating usage would remain constant on a volume of coating solids applied basis. Eliminating the small container exemption was assumed to result in an average reduction in RHC emissions from solvent-based specialty coatings sold in small containers of 75 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.89	1.24
1997	.92	1.27
2000	.94	1.30

Costs of Control

The cost-effectiveness of this measure is unknown, because it is difficult to predict the amount of research work necessary to apply waterborne or some other technology to a specific class of coatings. The South Coast AQMD expects the costs to be minor because the proposal is not completely technology forcing, but follows the current trend in architectural coating development. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

South Coast Air Quality Management District, Further Control of Emissions from Architectural Coatings, CM #88-A-8a.

CM# A2: IMPROVED INDUSTRIAL MAINTENANCE COATINGS RULE

Background

This control measure would reduce RHC emissions from industrial maintenance coatings used on architectural structures by lowering the VOC limits for some coatings, and by establishing additional substrate-specific VOC limits.

The regulatory focus for architectural coatings, including industrial maintenance coatings, continues to be to encourage coating reformulation to reduce the VOC content of coatings. Coating manufacturers are prohibited from manufacturing products which do not comply with specific VOC limits. In addition, end users are prohibited from applying coatings which do not meet the VOC limits.

The availability of low VOC coatings is dependent on the type of coating and desired coating characteristics. Many specialty coatings, including the industrial maintenance coatings, are available only in solvent-borne formulations which have relatively high VOC contents.

Regulatory History

Until January 17, 1990, industrial maintenance coatings were subject to District Regulation 8, Rule 3, Architectural Coatings. The industrial maintenance specialty coatings were removed from Rule 8-3 and made subject Rule 8-48, a new rule designed specifically for these specialty coatings.

The general VOC limit for industrial maintenance coatings is currently 420 grams/liter; effective September 1, 1992, this limit becomes 340 grams/liter. VOC limits have also been established for four other industrial maintenance specialty coating categories. Three of the four of these specialty coatings have more stringent "technology forcing" VOC limits that go into effect in 1992 and/or 1994.

Emissions Subject to Control

The affected source categories are various industrial maintenance architectural coatings. The emissions from associated cleanup solvent categories should also be reduced due to increased use of waterborne coatings; the emissions from cleanup solvent usage were not, however, included with this control measure in order to avoid overlap with CM# A18, "Substitute Solvents Used for Surface Preparation/Cleanup of Surface Coatings", which should provide more significant overall reductions in cleanup solvent emissions. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	3.04
1997	3.12
2000	3.19

Proposed Method of Control

This control measure will reduce the VOC limits for some industrial maintenance coatings below the current standards. This will force coating manufacturers to further develop waterborne and high solids coating technologies. The measure will also encourage the development of alternate technologies, such as the newly emerging reactive diluent technology. Reactive diluent coatings result in lower RHC emissions because most of the organic solvents chemically react to become part of the finished coating.

Emission Reductions Expected

In order to address uncertainty in the VOC levels that will be achievable for the coatings being considered, low and high emission reduction estimates were made. It was assumed that emissions from the affected categories would be reduced by 20 to 30 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.61	.91
1997	.62	.94
2000	.64	.96

Costs of Control

The cost-effectiveness of this measure is unknown, because it is difficult to predict the amount of research work necessary to apply waterborne or some other technology to a specific class of coatings. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

South Coast Air Quality Management District, Further Control of Emissions from Architectural Coatings, CM #88-A-8a.

CM# A3: IMPROVED AEROSPACE COATINGS RULE

Background

This control measure would reduce RHC emissions by establishing minimum transfer efficiency requirements for aerospace coating operations, and by reducing the VOC limits for some aerospace coatings.

The aerospace coating category includes the initial and rework coating of aircraft, helicopters, missiles, and related components. The coatings are applied for protection from environmental elements, drag resistance, and appearance. Rework involves the removal of the existing exterior surface coating and application of a new surface coating to assure that protection and performance characteristics are maintained. Interior component coatings are usually applied during original manufacture and remain for the life of the product. The coating process involves several steps, including surface preparation, basecoat and topcoat application, and cleanup. Organic solvent emissions result from the application and drying of the coatings and cleanup solvents for spray gun cleaning.

There are less than 10 major manufacturing and rework facilities in the District. There are probably hundreds of subcontractors within the District that at least occasionally coat aerospace components.

Regulatory History

The District regulates emissions of volatile organic compounds from aerospace coating under Regulation 8, Rule 29. Section 302 specifies the maximum VOC content for a variety of aerospace coatings. This section includes some reduced VOC limits with future effective dates of January 1, 1992. Rule 8-29 currently has no provision specifying minimum transfer efficiency.

The South Coast AQMD has adopted a control measure proposing to further reduce the VOC limits of aerospace coatings and to require a minimum 65 percent transfer efficiency for all aerospace coating operations in their 1989 AQMP revision (CM #88-A-4).

Emissions Subject to Control

The affected source category is *aerospace assembly and coating*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	1.11
1997	1.25
2000	1.30

Proposed Method of Control

It is proposed to require the use of transfer efficient coating application equipment. Transfer efficiency is defined as the ratio of weight or volume of coating solids adhering to the substrate to the total weight or volume of coating solids used in the process, respectively.

The majority of coatings used on aerospace components are applied by conventional air atomized spray, however, exterior plane surfaces are often done with electrostatic and roller application methods. Transfer efficiency for conventional air atomization is estimated to be in the range of 30 to 60 percent. The use of electrostatic technology in conjunction with conventional air atomized spraying procedures can achieve transfer efficiencies as high as 65 to 85 percent. This method is currently more applicable to initial coating applications. Rework application using electrostatics have shown problems relating to possible damage to on-board electronic components and fear of ignition of fumes in fuel tanks. In such cases, alternate technologies such as high volume, low pressure (HVLP) spray would be able to meet transfer efficiency requirements.

Aerospace coating manufacturers have developed successful phosphate-ester resistant primers with VOC contents of 350 grams per liter. A number of topcoats with VOC contents of 420 grams per liter have been developed. This is significantly below the current standard of 600 grams per liter, and well ahead of the January 1, 1992 effective date of the 420 gram per liter standard. Continued reformulation efforts should provide a wider range of low VOC coatings capable of meeting Federal Aviation Administration and Military Specification Standards. In particular, it is believed that lower VOC levels will be achievable for adhesive bonding primers, fuel tank coatings and sealant bonding primers.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Establishing a minimum transfer efficiency requirement was assumed to reduce aerospace coating emissions by 20 to 30 percent. An additional 5 percent reduction in emissions from coatings usage was estimated for lowering the VOC limits for selected coatings.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	0.28	0.39
1997	0.31	0.44
2000	0.33	0.46

Costs of Control

Implementation of transfer efficiency requirements will likely result in the modification of existing, or the purchase of new spray equipment. Conventional air atomized sprayers will be replaced by alternate spray guns or an electrostatic system, or ideally, a combination of both. New equipment costs are expected to be offset by a savings in paint consumption. The South Coast AQMD has estimated the range of cost associated with meeting a transfer efficiency requirement to be a savings of $6 to $22 per ton reduced due to an overall reduction in paint usage.

The costs of reformulation are unknown because it is not possible to predict the amount of research work necessary to develop lower VOC coatings. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

Transfer efficiency is a measure of coating waste. A higher transfer efficiency will result in less coating used per application and, therefore, less coating waste.

As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

Department of Health Services, State of California, 1986. Guide to Solvent Waste Reduction Alternatives. Alternative Technology and Policy Development Section, Toxic Substances Control Division. 1986.

South Coast Air Quality Management District, Staff Report, Proposed Amended Rule 1124, Aerospace Assembly and Component Coating Operations, February 14, 1990.

CM# A4: IMPROVED WOOD FURNITURE AND CABINET COATINGS RULE

(NOTE: THIS CONTROL MEASURE WAS ADOPTED ON APRIL 17, 1991)

Background

This control measure would reduce RHC emissions from wood furniture and cabinet coating operations by imposing VOC limits on the coatings used in the industry, and by deleting the small user exemption which currently exists.

The variety of coatings used by the industry includes fillers, sealers, primers, stains, lacquers, topcoats, and washcoats. These coatings are used to manufacture items such as kitchen and bathroom cabinets, tables, chairs, beds, sofas, shutters, and art objects.

There may be as many as one thousand facilities in the District that would be subject to this control measure.

Regulatory History

The District regulates precursor organic emissions from the wood furniture and cabinet coating industry under Regulation 8, Rule 32, which was adopted in 1983. Currently, Rule 8-32 does not have VOC limits for coatings, but does have a transfer efficiency requirement. Section 301 specifies the type of spraying equipment that is allowed under the Rule. (There are no specific transfer efficiency percentage requirements.) Essentially, any spraying technique except conventional air atomization is allowed under Rule 8-32. In addition, Section 110 exempts facilities with an annual coating usage of less than 500 gallons.

In 1988, the South Coast AQMD expanded their Rule 1136 to cover all wood products, not just furniture and cabinets. This revision also established interim and final VOC standards through July 1, 1996 for the following major coating categories: clear topcoat, filler, high solid stain, ink, mold-seal coating, multi-colored coating, pigmented coating, sealer, stripper, low solid stain, and toner or washcoat.

Emissions Subject to Control

The affected source categories are *wood furniture and cabinet coating and cleanup*. The emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	6.86
1997	7.67
2000	7.95

Proposed Method of Control

Coating reformulation is expected to be the predominant method of meeting VOC standards. However, successful reformulation has progressed slowly due to various

technical difficulties associated with developing coatings for wood substrates. For example, water-based formulations may cause the wood grain to rise, while high solid formulations sometimes do not give desirable appearances.

Data collected by the South Coast AQMD during their rule development process indicates that industry is beginning to use low VOC coatings. Emerging technologies such as UV-curable coatings are being developed, and technology transfer, such as powder coatings, may also result in acceptable products. For most wood coatings VOC limits of 275 grams per liter are believed to be achievable.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. The VOC limits are anticipated to be phased in with gradually more stringent standards over time. Emissions from coatings use are expected to ultimately be reduced by 80 to 90 percent. Emissions from cleanup solvent use were assumed to be reduced by 25 to 30 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	5.18	5.84
1997	5.79	6.52
2000	6.00	6.77

Costs of Control

A cost-effectiveness of $2000 per ton reduced was assumed, based on cost estimates used in the past for coating reformulation. This figure is significantly higher than the South Coast AQMD's cost estimates published for their amended rule in 1988, which range from a savings of over $300 per ton reduced to costs of about $200 per ton reduced. It is believed that the $2000 per ton reduced cost estimate is more appropriate considering the technical difficulties involved in wood coatings reformulation.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

South Coast Air Quality Management District, Supplemental Staff Report, Proposed Amended Rule 1136 - Wood Products Coating, July 5, 1988.

CM# A5: IMPROVED SURFACE COATING OF MISCELLANEOUS METAL PARTS AND PRODUCTS RULE

Background

This control measure would reduce RHC emissions by adding a transfer efficiency requirement, and by lowering VOC limits where feasible, for miscellaneous metal parts and products coatings.

A large variety of metal parts are coated both to prevent corrosion and to enhance appearance. Metal parts and products include, but are not limited to, farm machinery, small appliances, industrial machinery, and fabricated metal components. The coatings are applied either as part of the original equipment manufacturing (OEM) process or by special coating applicators (commonly called "job shops") whose sole business is the coating of a variety of parts. Before a coating is applied, parts are cleaned to remove grease, dust, or corrosion. Typical coating application methods include conventional spray, airless spray, electrostatic spray, flow coating, dipping, electrodeposition, and powder coating.

Spraying is the most common application method of applying primers, single coats, and topcoats. It provides a transfer efficiency typically ranging from 20 to 70 percent. For flow coating, metal parts are moved by conveyor through an enclosed booth. Inside, a series of nozzles shoot streams of coating, which "flow" over the part. Dip coating involves manual or automated immersion of the parts into a tank of coating. Both the flow and dip methods achieve transfer efficiencies in excess of 90 percent. In electrodeposition, parts are grounded and immersed in a bath of coating. Electrical potential causes the solids in the coating to adhere to the substrate. Powder coating is applied to parts by spraying. There is virtually no solvent in powder coatings. The parts are then moved to an oven where the paint particles melt and then flow over the part forming a continuous film.

Organic emissions from the coating of metal parts occur from the application, flashoff (prior to entering an oven), and drying processes. Generally, large industrial parts are air dried because of their size or because they contain heat sensitive materials. Small parts and assembly line types of parts are more likely to be force dried in ovens.

The number of facilities within the District that are subject to this control measure probably exceeds one thousand.

Regulatory History

The District regulates precursor organic emissions from metal parts coating under Regulation 8, Rule 19. Section 302 specifies the maximum VOC contents allowable for baked and air dried coatings. Baked coatings are defined as being dried at a temperature above 194°F. In addition to the general limits, Section 312 provides alternate limits for "specialty coatings" that are not readily available in low solvent formulations.

Currently, there is no transfer efficiency requirement in Rule 8-19. The District has considered adopting a transfer efficiency requirement in the past, but has elected not to do so in part because there was no reliable way to test for transfer efficiency. The South Coast AQMD, however, currently has a transfer efficiency requirement for metal parts coatings.

Emissions Subject to Control

The affected source category is *miscellaneous metal parts and small appliance coating.* The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.96
1997	1.01
2000	1.05

Proposed Method of Control

The use of transfer efficient equipment is proposed for metal parts coating operations. Transfer efficiency is defined as the ratio of the weight or volume of coating solids adhering to the substrate to the total weight or volume of coating solids used in the process.

Conventional air atomized spraying is the most wide-spread coating application method in the metal parts industry, achieving transfer efficiencies ranging from 30 to 60 percent. In recent years, a shift to more transfer efficient spraying techniques including airless, air assisted airless, electrostatic, and high volume, low pressure (HVLP) spraying has begun. There are a number of combinations of the above techniques (most of which involve electrostatics) which would achieve transfer efficiencies estimated to be in the range of 65 to 85 percent.

A minimum transfer efficiency standard in the metal parts rule would require most applicators to modify or replace their current spraying equipment with one or more of the spraying techniques discussed above.

Reformulation, rather than add-on controls, has been the means by which the metal parts coating industry has complied with current VOC limits for general coatings. However, there are still a number of "specialty coatings" with relatively high VOC content. Without more stringent limits, there is no incentive to reduce emissions from these coatings. Continued reformulation efforts should be able to provide low solvent substitute formulations for at least some of the specialty coatings.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Establishing a minimum transfer efficiency requirement was assumed to reduce RHC emissions from coatings usage by 25 to 35 percent. An additional 5 percent reduction in emissions was estimated for lowering the VOC limits for selected specialty coatings.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.29	.39
1997	.30	.41
2000	.32	.42

Costs of Control

Transfer efficiency requirements will result in the modification or replacement of conventional spray equipment. New equipment costs should be completely offset by a savings in paint consumption.

The cost of reformulation is not known because it is not possible to predict the amount of research necessary for a given coating category. It is likely that the cost per gallon of coatings will increase, but that this increase will be somewhat offset by a reduction in the volume of coating required, due to higher solids content. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

Transfer efficiency is a measure of coating waste. A higher transfer efficiency will result in less coating used per application and, therefore, less coating waste.

As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

Department of Health Services, State of California, 1986, Guide to Waste Reduction Alternatives, Alternate Technology and Policy Development Section, Toxic Substances Control Division.

CM# A6: IMPROVED SURFACE COATING OF PLASTIC PARTS AND PRODUCTS RULE

Background

This control measure would reduce RHC emissions by adding a transfer efficiency requirement, and by lowering VOC limits where feasible, for plastic parts and products coatings.

Plastic products include signs, computer and machinery housings, small appliances, and fixtures. Plastic products can be sprayed, flow coated, or dip coated. The particular application method depends on the product and its end use. Most single coating operations use spraying. Two-coat systems usually employ dip coating of the primer and spraying of the topcoat.

Emissions result from the application and drying of the coating, with most of the emissions occurring from the spray booth and the flashoff area. Due to the low melting point of plastics, most plastic parts are air dried rather than baked.

There are approximately fifty facilities in the District that would be affected by this control measure.

Regulatory History

The District regulates precursor organic emissions from plastic parts coating under Regulation 8, Rule 31, which was adopted in 1983. Section 302 contains a general VOC limit of 340 grams per liter of coating applied. In addition to the general limits, Sections 306 and 309 provide alternate limits for flexible coatings and "specialty coatings" that are not readily available in low solvent formulations.

Currently, there is no transfer efficiency requirement in Rule 8-31. The District has considered adopting a transfer efficiency requirement in the past, but has elected not to do so in part because there was no reliable way to test for transfer efficiency.

Emissions Subject to Control

The affected source category is *plastic parts and products coating*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.96
1997	1.08
2000	1.11

Proposed Method of Control

The use of transfer efficient equipment is proposed for plastic parts coating operations. Transfer efficiency is defined as the ratio of the weight or volume of coating solids adhering to the substrate to the total weight or volume of coating solids used in the process.

Conventional air atomized spraying is the most widespread coating application method in the plastic parts industry, achieving transfer efficiencies ranging from 30 to 60 percent. In recent years, a shift to more transfer efficient spraying techniques including airless, air assisted airless, and high volume, low pressure (HVLP) spraying has begun. There are a number of combinations of the above techniques which would achieve transfer efficiencies estimated to be in the range of 65 to 85 percent.

A minimum transfer efficiency standard in the plastic parts rule would require most applicators to modify or replace their current spraying equipment with one or more of the spraying techniques discussed above.

Reformulation, rather than add-on controls, has been the means by which the plastic parts coating industry has complied with current VOC limits for general coatings. However, the flexible coatings and specialty coatings still have relatively high VOC content. Without more stringent limits, there is no incentive to reduce emissions from these coatings. Continued reformulation efforts should be able to provide low solvent substitute formulations for at least some of these types of plastic coatings.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Establishing a minimum transfer efficiency requirement was assumed to reduce RHC emissions from coatings usage by 25 to 35 percent. An additional 5 percent reduction in emissions was estimated for lowering the VOC limits for selected specialty coatings.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.29	.39
1997	.32	.43
2000	.33	.45

Costs of Control

Transfer efficiency requirements will result in the modification or replacement of conventional spray equipment. New equipment costs should be completely offset by a savings in paint consumption.

The cost of reformulation is not known because it is not possible to predict the amount of research necessary for a given coating category. It is likely that the cost per gallon of coatings will increase, but that this increase will be somewhat offset by a reduction in the volume of coating required, due to higher solids content. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

Transfer efficiency is a measure of coating waste. A higher transfer efficiency will result in less coating used per application and, therefore, less coating waste.

As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

Department of Health Services, State of California, 1986, Guide to Waste Reduction Alternatives, Alternate Technology and Policy Development Section, Toxic Substances Control Division.

CM# A7: IMPROVED CAN AND COIL COATING RULE

Background

This control measure would reduce RHC emissions from metal container and coil coating by lowering the allowable VOC limits for some coatings.

Surface coatings are applied to metal containers, cylinders, pails, and drums to serve as liners and sealers, and to provide a protective and decorative finish. In coil coating, flat metal sheets that come in coils are typically roll coated on a production line basis. These metal coils are then formed or shaped into a variety of finished products such as gutters, siding, shelving, cans and many other items.

Organic emissions from can and coil coating operations occur in the coating application and flashoff areas, and in the baking ovens. The majority of the emissions occur before the coated metal coils or cans enter the ovens.

The District has 19 can plants, 5 drum and barrel plants, 2 crown and closure plants, and 14 miscellaneous fabricated metal plants. At least 2 of the 14 miscellaneous fabricated metal plants produce coated steel strapping. These totals are not cumulative as some plants fall into two categories.

Regulatory History

The District regulates precursor organic emissions from metal container, closure and coil coating under Regulation 8, Rule 11. Rule 8-11 was based on a Control Techniques Guideline (CTG) issued by EPA, which established VOC limits for the various types of coatings used in the industry. Rule 8-11 contains a provision for the use of non-complying coatings if equivalent emission reductions are achieved through the use of an approved control device, which is typically an incinerator. The Rule has been modified several times, most recently in 1989 when the allowable VOC content of some coatings were reduced, and abatement device requirements were made more stringent.

Emissions Subject to Control

The affected source category is *can and coil coatings*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	6.92
1997	7.55
2000	7.84

Proposed Method of Control

Coating technologies such as radiation curable, powder systems, water-borne, and high solids have the potential for further reducing VOC emissions from some can and coil coating operations. Radiation curable coatings are high solids formulations which contain

little or no organic solvents. These coatings use ultraviolet or electron beam energy to initiate the reaction to form a polymer surface coating. Radiation curable coatings, because of their high viscosity and need for control of coating thickness, are most amenable to flat stock roll coatings applications. Improvements in engineering have also allowed the application of radiation curable coatings on a three dimensional basis. Ultraviolet curable (UV) coatings systems are currently used by several companies in the District including Tri Valley and Beautrice/Hunt Wesson (Pacific Rim, which recently discontinued its local operation, also had a UV curable line).

Powder coatings may also represent an acceptable alternative to conventional, organic solvent based coating systems in certain applications. Powder coatings, applied as a powder and then baked in an oven to form a surface coating, are nearly 100 percent solids by weight. Myers Container Corporation uses a powder coating on the interior of some food product drums. Suitable powder coating systems may be able to be developed for other can and coil coating applications.

Some water-borne and high solids coatings that have VOC levels below existing standards may be suitable for certain can and coil coating applications. For example, an end sealing compound (Darex) is currently available with no VOCs. The use of this specific product could be encouraged by lowering the allowable VOC content for end sealing compounds. Because this product may not be suitable for all applications, a separate end sealing compound category for compatible products could be established.

Cleanup solvent usage is another area where further emission reductions may be possible in the can and coil coating industry. Solvents have been formulated that are citrus based, and other low VOC solvents have been formulated that are a mix of organic solvents plus water. These solvents are apparently quite suitable for wipe cleaning, which constitutes a major use of solvents in the can and coil coating industry. The feasibility of using low-VOC/low-vapor pressure surface preparation and cleanup solvents for all types of surface coating is being considered in a separate control measure.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from can and coil coatings usage by 5 to 10 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.35	.69
1997	.38	.76
2000	.39	.78

Costs of Control

According to EPA, the applied cost of radiation curable coatings is only slightly higher than for conventional solvent coatings, for the same area of coverage. If the operating costs

associated with abatement equipment for conventional coating systems are considered, a cost differential in favor of radiation curable materials may actually result. According to EPA, the applied cost of powder coating is less than the applied cost of conventional coatings. The costs of developing waterborne and high solids coatings with VOC levels below existing standards are difficult to estimate. Overall, it is believed that lowering the VOC limits for can and coil coatings will have a cost-effectiveness well within $2000 per ton reduced, which has been used in the past for coating reformulation.

It is believed that further reductions in emissions from existing abated sources should be relatively cost-effective. Inexpensive sheet metal additions could help improve capture efficiency without increasing the size of the abatement device. The cost-effectiveness of requiring continuous monitors on abatement devices is unknown at this time.

Other Impacts

Radiation curable coating systems use 75 to 90 percent less energy than conventional thermal curing systems. Available data indicate that some monomer emissions would be present in the exhaust for processes using radiation curable coatings, although further study is needed to better define potential toxic air contaminant problems. Particulate emissions from powder coatings are effectively controlled by fabric filtration.

As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

In some cases, additional control of VOC emissions by incinerators may be needed as a result of this control measure, possibly leading to an increase in natural gas consumption. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

References

Powder Coatings Technology Update, EPA 450/2-89-33.

Draft Evaluation of Radiation Curable Coatings as a Technology for Reducing VOC Emissions from Surface Coating Operations, EPA Control Technology Center, January 1991.

CM# A8: IMPROVED MAGNET WIRE COATING OPERATIONS RULE

Background

This control measure would reduce RHC emissions from magnet wire coating operations by expanding the applicability of existing requirements.

In magnet wire coating, insulation coatings such as varnish or enamel are applied to magnet wire while the wire is continuously drawn through a coating applicator. Volatile organic compound emissions from coating operations can be controlled by the use of low VOC coatings, or by the use of an emission control system which collects and abates emissions from coating, drying and curing exhaust streams.

There are currently no magnet wire coating operations operating in the District that are subject to existing source-specific requirements. The applicability of the existing rule is limited by exemptions for small users and for electrical subassemblies.

Regulatory History

The District regulates the emissions of precursor organic emissions from magnet wire coating operations under Regulation 8, Rule 26. This Rule establishes VOC limits for magnet wire coatings. The Rule also contains a provision for the use of non-complying coatings provided that an approved emission control system is used. Rule 8-26 exempts small sources with emissions less than 15 lb/day, and also sources that coat electrical machinery and subassemblies such as motor housings, rotors, stators and armatures. The exempt sources are subject to Rule 8-4, which is generally less stringent than Rule 8-26.

Emissions Subject to Control

The affected source category is *magnet wire coating*. The emissions from *other industrial/commercial coatings* were also assumed to be affected to a minor degree. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.22
1997	.23
2000	.24

Proposed Method of Control

By eliminating exemptions from the magnet wire coating rule, some additional sources will be subject to the existing standards. Electrical subassemblies, such as rotors and armatures are typically coated with varnish. Reformulation to water-borne or high solids coatings is the most likely method of compliance for these sources as well as for other small sources which are currently exempt. Technological advancements made in the reformulation of other industrial coatings and architectural coatings should be transferable to magnet wire coatings. RHC emissions from these operations can also be controlled with add-on

abatement devices, such as incinerators or carbon adsorption systems, if substitute low VOC coatings cannot be developed.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from affected coating operations by 50 to 60 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.11	.13
1997	.12	.14
2000	.12	.15

Costs of Control

The costs of control would stem from the research and development of complying coatings. A cost-effectiveness of $2000 per ton reduced was assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

None.

CM# A9: IMPROVED AUTOMOBILE ASSEMBLY COATING OPERATIONS RULE

Background

This control measure would reduce RHC emissions from automobile assembly plants by requiring the installation of exhaust controls on sources that do not have any substantial existing controls, and by requiring the use of lower VOC coatings where feasible.

New United Motor Manufacturing, Inc. (NUMMI) is the only automobile assembly plant located in the District. NUMMI currently operates an auto assembly line, and recently received an Authority to Construct for a second vehicle assembly line for light duty trucks.

The vehicle assembly process incorporates a series of surface coating applications throughout the assembly line. Coatings used include sealers, primers, undercoatings, anti-chip coatings, basecoats, clearcoats, and waxes. Coatings are applied with both manual and automated sprayers. Coating applications are generally followed by oven drying. Precursor organic emissions result from the spray booths, flashoff zones, setting zones, and ovens.

Regulatory History

The District regulates the emissions of precursor organic emissions from light and medium duty motor vehicle assembly plants under Regulation 8, Rule 13. This Rule establishes VOC limits for a variety of coatings used in the industry. The Rule also contains standards for transfer efficiency for most types of coatings. In lieu of a complying coating, a company may use an approved control device to meet the provisions of the Rule, but there are no specific requirements for coating operations to be abated.

The South Coast AQMD has adopted a control measure in their 1989 AQMP revision which proposes to further reduce emissions from automobile assembly plants by instituting controls similar to those proposed in this measure (CM #88-A-8a).

Emissions Subject to Control

The affected source category is *motor vehicle assembly plant coatings*. The emissions subject to control were adjusted to account for the fact that the new vehicle assembly line being added at NUMMI will already have BACT-level controls, and therefore should not be substantially affected by this control measure.

It is assumed that this control measure will not become effective until after the year 2000; the emission reduction estimates given here assume that the measure will become effective in the year 2001. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	3.44
1997	3.72
2000	3.85

Proposed Method of Control

Reformulation to low VOC coatings is the most cost-effective method of reducing the emissions of RHC from most surface coating operations. Although progress has been made in reformulating some types of automotive coatings, others (particularly color topcoats) continue to have relatively high VOC content. According to the South Coast AQMD, reformulation efforts are underway to develop high solids nonmetallic color coatings for use in electrostatic spray equipment. For metallic coatings, exempt solvent formulations are being developed. Although these types of coatings are not available at this time and may not be available in the near term, lowering the existing VOC limits would encourage coating reformulation, which is believed to be the most desirable method of reducing RHC emissions.

Currently, NUMMI controls emissions from their drying ovens with thermal and catalytic incineration. Other than the ovens, there are no additional add-on controls on the coating operations in the existing assembly line. In the NSR permit application for the second assembly line, NUMMI was required to control the automatic spray areas, flashoff and setting zones of the Primer/Surfacer, Topcoat I, and Topcoat II spray booths by exhaust recirculation/concentration and then carbon adsorption. The carbon adsorption units will be desorbed and the desorbed solvent will be destroyed by an incinerator.

There are several booths and zones at the NUMMI facility that are essentially uncontrolled. It is these uncontrolled areas that are the focus of this control measure. The same technology that is discussed above could be applied to similar uncontrolled coating sources.

Cleanup solvent usage is another area where further emission reductions may be possible at the NUMMI facility. Solvents have been formulated that are citrus based, and other low VOC solvents have been formulated that are a mix of organic solvents plus water. The feasibility of using low-VOC/low-vapor pressure surface preparation and cleanup solvents for all types of surface coating operations is being considered in a separate control measure.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Overall, this control measure was assumed to reduce RHC emissions from coatings usage by 20 to 30 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.69	1.03
1997	.74	1.12
2000	.77	1.16

Costs of Controls

In their review of a similar control measure, the South Coast AQMD estimates that add-on controls will cost $19,000 per ton of organics reduced. In their recent NSR permit application, NUMMI estimated the cost-effectiveness of add-on controls for the automatic primer and topcoat zones to range from $17,400 to $18,740 per ton reduced. These controls were deemed cost-effective, and therefore required as BACT. NUMMI also provided cost-effectiveness calculations for a number of other booths and zones which yielded significantly higher costs. Those control measures were not required as BACT. Calculations were based upon assumptions of 15 percent fugitive emissions and 95 percent destruction efficiency.

The cost-effectiveness of developing coatings with lower VOC limits is not known. Cost-effectiveness is difficult to predict for coating reformulation because the amount of research work necessary to develop a new coating formulation is difficult to predict. The costs of coating reformulation are usually offset somewhat by a reduction in volumetric coating usage (for higher solids coatings). A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

If additional control of VOC emissions by incinerators is needed as a result of this control measure, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be reactivated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

References

South Coast Air Quality Management District, Further Emission Reductions from Automobile Assembly Coating, CM #88-A-5.

Bay Area Air Quality Management District, Engineering Evaluation Report, Application Number 3611, New United Motor Manufacturing, Inc.

CM# A10: IMPROVED GENERAL SOLVENT AND SURFACE COATING RULE

Background

This control measure would reduce RHC emissions from general surface coating operations by encouraging the use of low VOC coatings and/or by establishing facility-wide emission limits for subject coating operations.

General surface coating refers to those coating operations which are exempted from or which are otherwise not subject to source-specific requirements. The standards for general coating operations do not expressly limit the VOC content of coatings, and therefore are generally less stringent than those affected by source-specific requirements.

There are less than 300 facilities in the District that have coating operations for which no source-specific requirements exist and therefore which are subject to general coating standards. Many more facilities have some coating subject to the general requirements because of specific exemptions from other coating rules (e.g. solid film lubricants, adhesives and stencil coatings).

Regulatory History

The District has approximately 46 rules designed to reduce precursor organic emissions from specific source categories. Many of these rules have exemptions for certain types of operations. Any coating source that is exempted from a source-specific rule then becomes subject to the general coating rule of Regulation 8, Rule 4. In addition, any operation for which no specific rule exists also is subject to Rule 8-4.

Rule 8-4 was the first major VOC rule adopted by the District, and it was designed to limit emissions of the more photochemically reactive organic compounds. The Rule contains definitions of "complying" and "non-complying" solvents and surface coatings which are based on the amount of specific types of organic compounds which are present in the solvent or coating. The VOC emissions from sources that use non-complying coatings are limited to 40 lbs/day, while sources which use complying coatings may emit up to 3000 lb/day.

In many instances, coatings with relatively high VOC content are allowed under Rule 8-4. Conversely, there are cases where a low VOC content coating may be acceptable for a given coating application, but is not allowed because it contains a particular organic compound in excess of the "complying" level. In this case, the Rule may require a company to use a higher VOC content coating that meets the "complying" definition.

Emissions Subject to Control

The affected source categories are *other industrial/commercial coating*, and *other organics -- evaporation*; only a portion of the total emissions in these categories were assumed to be affected. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	1.20
1997	1.26
2000	1.30

Proposed Method of Control

This control measure proposes to reduce precursor organic emissions from general surface coating operations by (1) allowing the use of low VOC coatings as an alternative to "complying" coatings, or by redefining "complying" coatings using a reasonable VOC limit (e.g. 420 gram/liter VOC limit) rather than a solvent composition definition, and/or (2) adding standards for facility-wide caps for coating operations subject to Rule 8-4.

Because of the low VOC standards of other District rules, there are already a wide variety of surface coatings available with VOC contents less than 420 grams per liter. It is anticipated that acceptable low VOC coatings will be available for many coating applications affected by this control measure.

Another option for reducing emissions from general coating sources would be to replace the emission limits for individual operations with a facility-wide cap on emissions from general surface coatings. The existing emission limits in Rule 8-4 are expressed in terms of the allowable emissions from individual operations. For most facilities, these limits are not very restrictive (particularly for complying coatings), and therefore offer little incentive for companies to reduce emissions. A facility-wide cap would encourage facilities to seek means to reduce overall VOC emissions from affected sources. Emission limits could be met by using low VOC coatings, higher transfer efficiency application methods, or add-on controls.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from coatings usage by 20 to 30 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.24	.36
1997	.25	.38
2000	.26	.39

Costs of Controls

If facilities are given the <u>option</u> of using low VOC coatings or complying with the existing requirements, it is assumed that low VOC coatings would be used only where a cost savings would result. If the definition of a "complying" coating is modified to be expressed in

terms of VOC content, some facilities would need to reformulate their coatings. The costs of coating reformulation are usually offset somewhat by a reduction in volumetric coating usage (for higher solids coatings). A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

The costs associated with a facility-wide cap on general solvent emissions would depend on the source types, the amount of emissions relative to the cap limit, and the type of control necessary to reduce emission below the cap level. Given the variety of industrial sources subject to the general solvent and surface coating rule, it is not possible to calculate a meaningful overall cost-effectiveness number at this time.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. As waterborne technology in coatings increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if coatings are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

None.

CM# A11: FURTHER CONTROL OF EMISSIONS FROM ADHESIVES USE

Background

This control measure would reduce RHC emissions by establishing a specific rule for adhesives use that would limit the VOC content of adhesives, require the use of high transfer efficiency application methods, and limit the emissions from cleanup solvent.

Adhesives are used in a wide variety of industrial applications. Adhesives such as glue, mucilage, paste, and rubber cement are used to bind similar and dissimilar materials (e.g. glass, plastic, rubber, wood, and metal) together. These types of adhesives work when the surfaces of the materials adhere to the adhesive and it is the strength of the surface adhesion and the material strength of the adhesive which holds the two materials together. Other types of adhesives, such as cement, dissolve the surfaces of the substrates, and with the aid of solid ingredients, fuse and chemically bond the surfaces together.

Some of the different types of adhesives are contact adhesives, heat cured adhesives, hot-melt, UV-cured, elastomeric, epoxy, pressure sensitive, anaerobic, aerobic, catalyzed-cured, RF-cured, solvent cements, plastic cements, weld solvents, high frequency cured, and vinyl adhesives. Adhesives can be applied by a variety of methods, including brush, roller, flow, spraying, hot-melt, and laying of adhesive sheets.

Organic solvent-borne adhesives are the main source of RHC emissions in this source category. Solvents are the media for transferring the adhesive materials to the substrates, and must be capable of dissolving all of the various adhesive components. The solvents must have the ability to wet the substrate, to promote adhesion, and to have a viscosity which allows for uniform application of the adhesive. For most adhesives, VOC emissions occur from evaporation of the solvent before bonding.

There are probably thousands of companies located within the District that use some type of adhesives that would be affected by this control measure.

Regulatory History

The District does not currently have a rule specific to adhesive applications. Most source-specific rules exempt adhesives and, therefore, adhesive applications usually default to Rule 8-4, General Solvent and Surface Coating Operations. Rule 8-4 limits daily emissions from general sources, but does not contain specific VOC limits for coatings.

The South Coast AQMD has adopted a rule specific to adhesive applications (SCAQMD Rule 1168). The general VOC limit in this Rule, which became effective on January 1, 1991, is 250 grams per liter. SCAQMD Rule 1168 also has other special VOC limits for certain types of adhesives or types of substrates being bonded.

Emissions Subject to Control

The affected source categories are *adhesives and sealants, solvent base*. The majority of the emission reductions from this control measure will come from establishing VOC limits, which are anticipated to become effective in the year 1995. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	2.24
1997	2.39
2000	2.49

Proposed Method of Control

To control RHC emissions from adhesive applications, a new District rule similar to the existing SCAQMD Rule 1168 is proposed. A general VOC limit for adhesives of 250 grams per liter is proposed. In addition, requirements for increased transfer efficiency and closed systems for cleanup solvents are anticipated.

The primary means of complying with the VOC limit will be reformulation. Low VOC adhesive formulations include water-base, hot-melt (solventless), high solids, and polymerizing adhesives.

Water-base: Water-base adhesives use water to replace some or all of the organic solvents in the mixture. Water-base adhesives may dry more slowly than solvent-base and therefore may decrease production rates. Adhesive applicators may be able to compensate for this, however, by installing drying ovens.

Hot-Melt: Hot-melt adhesives contain no organic solvent and therefore, produce no VOC emissions. These materials are solid at room temperature and are applied using heat to melt the adhesive. However, hot-melt adhesives set up very quickly, are not flexible, and may require some modification to the manufacturing process in order to be used.

High Solids: High solids adhesives contain a higher ratio of solids to solvent than do conventional adhesives. This reduces VOC emissions because an adhesive applicator can use less product to apply a given amount of adhesive solids. The disadvantage of high solids adhesives is that they may be too viscous to apply in a uniform layer.

Polymerizing Adhesives: Polymerizing adhesives, which contain no VOC, are liquid at application and become solid when cured. These adhesives may require the installation of a UV-lamp or the introduction of a chemical free radical initiator to begin the polymerization reaction. These materials have better penetration than hot-melt adhesives, but have limited flexibility.

High transfer efficiency application methods such as electrostatic and high volume -- low pressure sprayers, roll coaters, and hand applicators can be used with adhesives to reduce the amount of material used. In some cases with high viscosity adhesives, conventional application methods such as air-atomized or airless spraying can be used with good results. Heating may also be used to improve transfer efficiency.

This control measure is also directed at reducing cleanup solvent emissions from the use of adhesives. To comply with such a provision, equipment can be cleaned in a container that is kept closed except when in use. Spray guns can be cleaned so that solvent is collected in an enclosed container. Used solvents may be recycled in an on-site distillation unit, or reclaimed by a dedicated recycling facility.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from adhesives use by 70 to 80 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	1.57	1.79
1997	1.67	1.91
2000	1.74	1.99

Costs of Controls

The costs of complying with this control measure are divided into three parts: the cost of reformulation, the cost of high transfer efficiency application, and the cost of meeting cleanup solvent requirements. All cost estimates are taken from the South Coast AQMD's staff report for Rule 1168, dated March 29, 1989.

The costs of using low VOC adhesive formulations will vary depending on the adhesive technology and the application technique. The range of material costs will vary from a savings of $534 per ton reduced to costs of $5447 per ton reduced, with an average cost of $2000 per ton of VOC reduced. Water-base adhesives may be more expensive to implement because their increased drying time may decrease production rates or require the addition of drying ovens.

The cost of high transfer efficiency application methods will depend on the type of equipment used. The South Coast AQMD estimated the cost of using high volume, low pressure sprayers to be approximately $2,000 per ton of VOC emissions reduced.

The cost of complying with the cleanup solvent requirements by using a closed equipment cleaning system is estimated to be a savings of $64 per ton of emissions reduced. The cost of using low VOC cleanup solvents will vary depending on formulation. Exempt-solvent and water-base formulations are expected to cost about $2 and $1 more per gallon, respectively, than conventional cleanup solvents.

Other Impacts

Transfer efficiency is a measure of coating (adhesive) waste. A higher transfer efficiency will result in less coating used per application and, therefore, less coating waste.

As waterborne technology in adhesives increases, environmental benefits will result from the reduction in solvent waste generated in manufacturing and user cleanup. There is the possibility of an increase in emissions of stratospheric ozone depleting substances (such as 1,1,1 trichloroethane) and potentially toxic substances (such as methylene chloride) if adhesives are reformulated with non-precursor ("exempt") solvents. The District may not, however, allow these types of solvent substitutions.

References

South Coast Air Quality Management District, Staff Report, Proposed Rule 1168, Control of Volatile Organic Compound Emissions from Adhesive Applications, March 29, 1989.

CM# A12: ELIMINATION OF COATING RULES ALTERNATIVE EMISSION CONTROL PLANS

Background

This control measure would reduce RHC emissions by removing Alternative Emission Control Plan (AECP) provisions from applicable District surface coating rules.

AECPs provide facilities with increased flexibility in achieving overall emission reductions. Under an AECP, some individual sources are allowed to emit more than the applicable standards, provided that the excess emissions are offset by controlling other sources beyond what the standards require.

AECPs rely on the transfer of "emission credits" between affected sources. Eliminating AECPs should reduce emissions by requiring each source or coating to meet applicable standards. The emission reductions from sources or coatings which "over-comply" could no longer be used to allow the use of non-complying sources or coatings. In addition, due to the complexity of verifying compliance under an AECP, the proposed control measure would increase the ability for emission standards to be enforced.

The following six companies currently have AECPs, or are in the process or obtaining an AECP:

Plant No.	Company Name	District Rule of Reg 8
58	American National Can	11
152	Tri Valley Growers Container ...	11
218	Beautrice/Hunt Wesson Division	11
401	Packaging Industries, Inc	20
1761	Myers Container Corp	11
2173	Crown Cork and Seal (formerly Continental Can Co)	11

Regulatory History

The District and the EPA have allowed the use of AECPs for many years, although the degree of flexibility allowed within AECPs has generally decreased. This control measure proposes to eliminate the remaining AECPs which do not conform to EPA's 1986 Federal Emissions Trading Policy, as well as the AECPs which are considered EPA "approvable". The District has eliminated non-approvable AECP provisions from all but two District rules: (1) Rule 8-32, Wood Furniture and Cabinet Coatings, and (2) Rule 8-43, Surface Coating of Marine Vessels. It should be noted that there are no facilities currently operating under AECPs in either of these two rules.

Approvable AECPs include: (1) Rule 8-20, Graphic Arts Printing and Coating Operations, and (2) Rule 8-11, Metal Container, Closure and Coil Coating. Rule 8-20 has two AECP provisions: one for sources that had an AECP prior to May 26, 1988, and another with more stringent requirements for sources submitting plans after that date. The AECP provisions of Rule 8-11 pertaining to can plants meet the less stringent emissions trading policy implied in an EPA interoffice memo of December 8, 1980. The can industry has referenced this document as an exemption from the 1986 Federal Emissions Trading Policy.

Emissions Subject to Control

The affected source categories are *can and coil coating* and certain printing categories. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	8.00
1997	8.68
2000	9.00

Proposed Method of Control

The affected facilities would have to comply by using complying coatings or by abating emissions. The can manufacturers have claimed that a wide range of coatings that comply with existing VOC limits are not available. For cases where acceptable complying coatings could not be developed, the use of add-on abatement devices such as incinerators or carbon adsorbers would be necessary.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from affected source categories by 2 to 4 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.16	.32
1997	.17	.35
2000	.18	.36

Costs of Control

It is believed that the majority to the affected companies will be able to come into compliance by switching to complying coatings. The cost of reformulation is not known because it is not possible to predict the amount of research necessary for a given coating category. It is likely that the cost per gallon of coatings will increase, but that this increase will be somewhat offset by a reduction in the volume of coating required, due to higher solids content. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating reformulation.

Other Impacts

There is a possibility of an increase in the emissions of substances which may be toxic or deplete upper atmospheric ozone if coatings are reformulated with non-precursor or "exempt" solvents. The District, however, may not allow these type of solvent substitutions. If incinerators are used as abatement devices, some increases in fuel consumption and NOx emissions will result.

If additional control of VOC emissions by incinerators is needed as a result of this control measure, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

References

EPA Federal Emissions Trading Policy, 51FR 43813.

Compliance with VOC Emission Limitations for Can Coating Operations, 45FR 80024.

CM# A13: IMPROVED GRAPHIC ARTS PRINTING AND COATING OPERATIONS RULE

Background

This control measure would reduce RHC emissions from graphic arts printing operations by (1) reducing the allowed amount of organic solvent in fountain solutions used in offset lithography, (2) requiring the use of automatic washing systems for cleaning large printing presses, (3) requiring the use of lower VOC inks and, (4) requiring enclosure of doctor blades used for defining the ink layer on printing cylinders.

The graphic arts industry produces advertising copy, flexible packaging, floor coverings, magazines, newspaper supplements, posters, and wallpaper. Graphic arts operations consist of the two broad categories of printing and coating. Printing involves impressing color, design, or words on individual sections of substrate (e.g. paper) or on a continuous roll (web) of substrate, not necessarily covering the entire surface.

Offset lithography involves the printing of an etched image from a plate, parts of which are inked and other parts of which are treated to repel ink. Fountain solutions are used to maintain the hydrophilic properties of the non-image areas and to keep the non-image areas free from ink. The fountain solutions usually contain isopropanol.

Flexographic printing is the application of words, designs, and pictures to a substrate by means of a roll printing technique (most processes are web fed). In this method, ink is applied to a rubber cylinder which in turn applies the ink to the substrate.

In gravure printing, the image area is engraved relative to the surface of the image carrier. The gravure cylinder rotates in an ink trough or fountain. The ink is picked up in the engraved area, and is scraped off the non-image area with steel "doctor blades".

There are approximately 80 large facilities in the District conducting graphic arts coating operations. There are probably thousands of small offset printing shops operating within the District.

Regulatory History

The District regulates the emissions of precursor organics from the graphic arts industry under Regulation 8, Rule 20. Rule 8-20 currently limits the VOC content of fountain solutions to 15 percent, by volume. Low VOC inks, coatings and adhesives with a VOC content less than 300 grams per liter are currently allowed under Rule 8-20.

As an alternative to low VOC materials, emissions may be controlled by an approved add-on emission control system. Collection systems must be designed for "maximum collection of fugitive emissions", although specific design criteria are not specified.

Section 307 of Rule 8-20 governs the use of cleanup solvents, but only requires that solvents and rags be stored in closed containers. No particular cleaning methods or materials are currently mandated.

The South Coast AQMD has a similar graphics arts rule (SCAQMD Rule 1130). SCAQMD Rule 1130 limits the VOC content of fountain solutions to 100 grams per liter, effective January 1, 1991.

Emissions Subject to Control

The affected source categories are the various printing categories including *offset lithographic printing*, *flexographic printing* and *rotogravure printing* (only a portion of the total emissions from printing categories will be affected by this control measure). The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.73
1997	.79
2000	.82

Proposed Method of Control

This control measure would reduce the allowable amount of organic solvent in fountain solutions. Reductions in fountain solution VOC content from the existing 15 percent standard to 10 percent are believed to be feasible. This would be accomplished by reformulation of fountain solutions. There has been considerable work in this area in recent years, and solvent contents currently range from ten to fifteen percent. Further reformulation will most likely be required to meet the 10 percent limit.

This control measure also would require the use of an automated system, instead of manual wipe cleaning, to clean the printing cylinders of large printing presses. These cleaning systems can be used in web or sheet-fed printing operations. Similar wash systems are currently being used in the District by California Color Printing in Pittsburg and by First Western Graphics in San Leandro.

In the automated wash process, the cleaning solvents are transferred to the web or sheet, and about two-thirds of the solvents are recovered. The remainder of the solvent evaporates in the drying oven. Drying oven exhaust is then controlled by an add-on abatement device, if present. The net result is that less cleaning solvent is used and cleaning solvent emissions are abated. Note that this system may only be proposed for presses whose emissions are abated downstream. If no abatement device exists, the solvent from the wash system would be emitted to the atmosphere.

Another part of this control measure involves reducing the amount of organic solvent allowed in low VOC inks for certain printing processes. Presently, waterborne inks contain between 50 and 285 grams VOC per liter. New technology exists which replaces solvent with soya bean oil. These inks contain between 15 and 105 grams VOC per liter and are already in use in certain printing operations in the District.

Finally, this control measure proposes to reduce fugitive VOC emissions by requiring the enclosure of doctor blades, which are used on rotogravure and some flexographic presses. This requirement will reduce VOC emissions by increasing capture efficiency.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from offset printing operations by 30 to 40 percent. The affected emissions from other printing operations were assumed to be reduced by 20 to 30 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.17	.24
1997	.19	.26
2000	.19	.27

Costs of Control

Fountain solutions currently contain between 10 and 15 percent organic solvent, which is typically isopropyl alcohol. The cost-effectiveness of reducing the allowable limit to 10 percent is difficult to calculate because it is not possible to predict the amount of research and development work necessary to develop a satisfactory product.

The primary benefit of the automated blanket washer, from a manufacturing standpoint, is that it greatly reduces the amount of cleaning solvent used and the amount of press downtime relative to manual wipe cleaning. In light of this, automated wash systems should result in a cost savings. Information received from manufacturers indicates that an automated wash system could pay for itself within 6 months to one year.

The cost of ink reformulation is not known because it is not possible to predict the amount of research necessary for a given ink category. It is likely that the cost per gallon of ink will increase somewhat. A cost-effectiveness of $2000 per ton reduced is assumed, based on cost estimates used in the past for coating and ink reformulation.

The costs of enclosing doctor blades should not exceed $10,000 per press. The cost-effectiveness of this measure is unknown because the fugitive emissions from these sources have not been adequately quantified.

Other Impacts

Decreasing the organic solvent content of fountain solutions used in offset lithographic printing presses is not expected to have any significant adverse impacts.

The use of an automatic blanket washer would reduce cleaning solvent usage, which in turn, would reduce the amount of spent solvent or hazardous waste that would need to be transported off site. If additional control of RHC emissions by incinerators is needed as a result of this control measure, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in

certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

There is a possibility of an increase in the emissions of substances which may be toxic or which deplete upper atmospheric ozone if inks are reformulated with non-precursor or "exempt" solvents, although this has generally not occurred in the past. In any event, the District may not allow these type of solvent substitutions.

Enclosing doctor blades will not produce any significant adverse environmental impacts. Some reductions in VOC levels in the workplace should result due to increased capture of fugitive emissions.

References

South Coast Air Quality Management District, Proposed Amended Rule 1130 - Graphic Arts, Public Notice, February 22, 1990

Oxy-Dry Corporation, Brochure for Oxy-Dry Automatic Blanket Washer

Precision Engineered Systems, Inc., Brochure for Precision Automatic Blanket Wash System

CM# A14: IMPROVED COATINGS AND INK MANUFACTURING RULE

Background

This control measure would reduce RHC emissions from coating and ink manufacturing operations by establishing more stringent requirements for vat mixing and cleaning operations, by eliminating existing exemptions, and by extending the applicability of control requirements to cover adhesives manufacturing.

Surface coatings are manufactured by mixing solid powders to suspend them in a volatile liquid media. Coatings can be categorized as being either "trade sales" or industrial use coatings. Trade sales are paints such as house paints and other products marketed to the general public, professional painters and contractors. The other major market is industrial use coatings for products finishing. These products are sold directly to the original equipment manufacturer for factory applications such as automobiles, appliances, and can coatings for the food and beverage industry.

Almost every surface coating contains a resinous or resin-forming component called the binder. The binder can be a liquid, such as a drying oil, or a resin that can be changed to a solid by chemical reaction. Sometimes, if the binder is too viscous for application, a volatile solvent (thinner) is added. The binder and the solvent are together known as the vehicle. The other component of the coating is a pigment which imparts color and opacity to the paint. Other additives which are mixed with coatings to influence their properties are called extenders.

The general resin types used for manufacturing coatings are: alkyds, cellulosics, acrylics, vinyls, phenolics, epoxies, polyurethanes, silicones, amino resins and latexes. A wide variety of organic solvents are used in coatings manufacturing including: hydrocarbons such as naphtha, mineral spirits, toluene and xylene; alcohols such as methyl, ethyl and butyl alcohol; ethers such as dimethyl ether and ethylene glycol; ketones such as acetone, MEK, and MIK; esters such as ethyl and butyl acetate and; chlorinated solvents such as tetrachlorethane.

Printing inks can be divided into the letterpress and lithographic inks commonly called oil or paste inks, and flexographic and rotogravure inks, which are referred to as solvent inks. Printing inks are usually manufactured in three steps: (1) cooking the vehicle and adding dyes, (2) grinding a pigment into the vehicle using roller mills and, (3) the flushing process, which involves replacing water in the wet pigment by an ink vehicle. Typical organic compounds used in ink manufacturing are fatty acids, glycerine, phenols, aldehydes, ketones, terpenes oil and thinning solvents.

Emissions from the coatings and ink manufacturing process mostly consist of RHC emitted from cooking, mixing and solvent cleaning operations.

There are approximately five ink and thirty coating manufacturing plants located within the District.

Regulatory History

The District regulates precursor organic emissions from coatings and ink manufacturing under Regulation 8, Rule 35. Rule 8-35 establishes control requirements for stationary vats, and for the operation and cleaning of mixing vats and grinding mills. Stationary vats

which emit more than 15 lb/day must be controlled by an abatement device. For mixing operations, Rule 8-35 requires that affected equipment remain covered, except for adding ingredients or taking samples. Rule 8-35 currently exempts small manufacturers where coating/ink production is under 500 gallons per day, and equipment used for manufacturing waterbased coatings. The Rule currently does not explicitly apply to adhesives manufacturing.

Emissions Subject To Control

The affected source category is *coatings and inks manufacturing*. Only a portion of the total emissions in this category was considered to be subject to this control measure. The projected RHC emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.77
1997	.83
2000	.86

Proposed Method Of Control

Several control options directed at further reducing RHC emissions from coatings and ink manufacturing are under consideration. Emissions from mixing operations and mills could be further reduced by collecting fugitive emissions and venting them to an abatement device such as a carbon adsorption system or an incinerator. This requirement could be specified for vats or groups of vats of a specified size or emissions level, perhaps by lowering the existing 15 lb/day cutoff for abatement of stationary vats.

It is also proposed to extend the applicability of the existing Rule 8-35 by eliminating exemptions and by subjecting adhesives manufacturing to control requirements. These changes would reduce emissions by subjecting more sources to control requirements.

Finally, more stringent requirements for vat cleaning are proposed. Emissions from vat cleaning can be reduced substantially by using low volatility and/or low VOC cleanup solvents. Fully enclosed, automatic cabinet washing systems that use water-soluble cleaning solutions are available for washing vats and tanks

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that eliminating exemptions and adopting more stringent vat cleaning requirements would reduce RHC emissions from affected sources by 20 to 30 percent. Abating fugitive emissions from mixing vats was assumed to reduce RHC emissions by 60 to 80 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.46	.62
1997	.50	.67
2000	.52	.69

Costs Of Control

It is anticipated that abatement requirements for mixing vats will be established only for those sources with relatively significant emissions. For these sources, a typical control system is expected to have capital costs of about $30,000 to $150,000 and operating costs of $15,000 to $80,000 per year. The cost-effectiveness of these controls should not exceed $6000 per ton of RHC reduced.

The costs for covering mixing vats range from $500 to $2000 depending on the size of the tanks. The cost of fitting mixing vats with covers would be recovered in solvent savings within 2 to 6 years.

The capital cost for self contained cleaning systems is estimated to be about $18,000, with an operating cost of $4,800 per year. The costs of the automated cleaning systems are, however, estimated to be lower than the costs for the manual cleaning methods currently in use. An overall cost savings is therefore expected.

Other Impacts

No significant adverse environmental impacts are expected to result from implementation of this control measure.

If additional control of RHC emissions by incinerators is needed as a result of this control measure, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

A reduction in the emissions of odorous compounds may occur due to further RHC reductions.

References

U.S. Environmental Protection Agency, EPA 450/3-90-006, 1990.

The Encyclopedia of Chemistry, third edition, Hampel & Hawley.

Technical Assessment Memorandum for Coating and Ink Manufacturing, BAAQMD, December 14, 1990.

CM# A15: IMPROVED RESIN MANUFACTURING RULE

Background

This control measure would reduce RHC emissions from resin manufacturing operations by requiring abatement of pellet extrusion and final product packaging.

Resin, which is a basic component of plastics and surface coatings, is defined as solid or semi-solid organic substances with little or no tendency to crystallize. Resins can be divided into two groups, thermoplastic and thermosetting. The thermoplastic resins do not change their physical properties upon heating, while the thermosetting resins undergo physical changes when heated.

The types of resins commonly used in the industry are: polyethylene, polyvinyl, polystyrene, polypropylene, phenolic, polyester and amino resins. Typical organic compounds used in resin manufacturing are: linseed oil, mineral spirits, MEK, MIK, toluene, xylene, ethyl and butyl acetate, styrene, butyl cellosolve, ethylacrylate and cyclopentadiene.

Resins are generally manufactured in pressurized, jacketed, heated vessels equipped with stirring mechanisms. To prevent RHC and odor emissions, depressurization (venting) of the resin reactors is usually done through a condenser followed by a carbon adsorption system or by incineration. Fugitive RHC losses may occur in several steps of the manufacturing process, including pellet extrusion and the final product packaging.

There are approximately ten plants involved in resin manufacturing within the District. Some of these plants manufacture other products from their resins. Most existing resin manufacturing plants are currently equipped with some RHC and odor control devices.

Regulatory History

The District regulates precursor organic emissions from resin manufacturing under Regulation 8, Rule 36. Rule 8-36 requires control of emissions from resin reactors, thinning tanks and blending tanks. Facilities with RHC emissions that do not exceed 10 pounds per day from these sources are not subject to the control requirements. Fugitive emissions from pellet extrusion and final product packaging are currently not covered by Rule 8-36.

Emissions Subject To Control

The affected source category is *resins manufacturing*. The projected RHC emissions in this category are given below. This control measure would affect only a portion of the emissions within this category. Because the emissions from the affected sources have not yet been determined, the emissions subject to control are considered unknown.

Year	Category Emissions Control (TPD, Summer)
1994	.03
1997	.03
2000	.03

Proposed Method Of Control

This control measure would require abatement of two additional emission points in the resin manufacturing process, pellet extrusion and the final product packaging. In addition to controlling emissions from the resin manufacturing vessels, the two largest resin manufacturing plants in the District also control odor and fugitive RHC emissions (including emissions from pellet extrusion and final product packaging operations) with additional carbon adsorption units installed on the building exhaust. The resin building is kept under negative pressure by venting the inside air through a non-regenerable carbon adsorption unit which, due to the low concentrations of RHC, can perform satisfactorily for relatively long periods of time before replacement is necessary. This control measure would require similar controls for other resin manufacturing plants. As an alternative to abating the exhaust from the entire building, it may be possible to provide local ventilation and control of pellet extrusion and packaging areas.

Emission Reductions Expected

The types of abatement devices that are expected to be used for reducing RHC emissions typically have control efficiencies in excess of 90 percent. Because the emissions subject to control have not yet been quantified, however, emission reduction estimates are currently not available.

Costs of Control

Most of the resin manufacturing plants in the District are already equipped with RHC control devices. The extent to which these existing devices could be used to reduce RHC emissions from pellet extrusion and final product packaging is not known. The overall cost-effectiveness of this control measure has not been determined at this time.

Other Impacts

A reduction in the emissions of odorous compounds should result. Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

References

U.S Environmental Protection Agency, EPA-650/2-74-106, 1974.

U.S Environmental Protection Agency, AP40, 1973.

CM# A16: IMPROVED SEMICONDUCTOR MANUFACTURING OPERATIONS RULE

Background

This control measure would reduce RHC emissions from semiconductor manufacturing facilities by requiring abatement of positive photoresist operations and cleaning operations that use coating-type application equipment.

Semiconductor manufacturing operations use organic solvents as carriers and developers for photoresist and for cleaning. The photoresist process is the means by which circuitry is added to chips. A layer of resist is applied to a silicon wafer, the wafer is exposed to a pattern of light, and either the exposed or the unexposed resist is removed or "developed." Negative photoresist is the process where the unexposed resist is removed; positive photoresist is the process where the exposed resist is removed. Negative photoresists are traditionally xylene-based; positive photoresists traditionally use cellosolves as carriers, and caustics as developers.

The other area of significant solvent usage in semiconductor manufacturing is in cleaning. Semiconductors have an intense need for cleanliness and particle control because the circuitry is so miniaturized. Very small amounts of contamination, in chemical or particulate form, will ruin chips. Therefore, these facilities use large amounts of high purity solvents and water to remove particles and chemical contamination from their work-in-process. These cleaning steps are often performed after each operation. Due to the contamination problems, pure virgin solvent is generally used. These facilities tend to leave the recycling and purification of solvent to firms who handle their waste. For this reason, these firms have a high gross usage of solvent.

Regulatory History

The District regulates the emissions of precursor organics from semiconductor manufacturing operations under Regulation 8, Rule 30, which was first adopted in 1983. Rule 8-30 requires 90 percent reduction of RHC emissions from negative photoresist operations. There are no control requirements for positive photoresist. In the original semiconductor rule, control of solvent stations was achieved with cover and freeboard requirements; there were no restrictions on reservoir size or solvent flow.

Rule 8-30 was amended on March 6, 1985. In this rule revision, the definition of semiconductor manufacture was expanded, and interim limits for solvent stations were added. Abatement devices, including scrubbers, were allowed as controls for solvent stations.

The most recent revisions to Rule 8-30 were made on November 23, 1988. The exemption for negative photoresist operations at facilities emitting less than 15 lb VOC per day was changed to an exemption for facilities that consume less than 24 gallons per month of combined negative photoresist and developer. This exemption is being interpreted as net usage (i.e. evaporation) of 24 gallons per month. Two solvent station restrictions were added: solvent flow and solvent reservoirs larger than ten gallons were not allowed. These sources are now subject to Rule 8-16, Solvent Cleaning Operations. A distinction was also made between containers and reservoirs (reservoirs are subject to freeboard requirements). Final solvent cleaning station limits which excluded scrubbers were also added.

The South Coast AQMD has a semiconductor manufacturing operations rule (SCAQMD Rule 1164) which subjects both positive and negative photoresist operations to 90 percent control of RHC emissions.

Emissions Subject to Control

The affected source category is *semiconductor manufacturing*. Only five percent of the emissions in this category are estimated to be subject to this control measure. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.08
1997	.09
2000	.09

Proposed Method of Control

At present, Rule 8-30 requires 90 percent abatement of RHC from negative photoresist operations. Most existing installations use incineration for controlling emissions. The photoresist is sprayed on the product, then spun off. The organic solvents have ample opportunity to evaporate because there is a large liquid-vapor interface, and because air is evacuated from this equipment to protect the workers and to keep the concentration below the lower explosive limit. The District assumes that 90 percent of the VOC in negative photoresist is volatilized during application. The solvent used in negative photoresist is often xylene or a solvent of similar volatility.

The District has not developed an emission factor for positive photoresist and is currently using the 90 percent factor developed for negative photoresist. It is believed, however, that positive photoresist applicators emit less VOC than negative photoresist because the solvents used are less volatile. The carrier in positive photoresist is cellosolve or cellosolve acetate. The developer is generally tetramethyl ammonium hydroxide, which has a very low volatility. N-methyl pyrrolidone, another low volatility solvent, is also being used as a positive photoresist developer.

A requirement for abatement of all photoresist applicators, both negative and positive, is being considered. If positive photoresist emissions are significant, these sources could be abated with the same types of add-on control devices used for negative photoresist sources. Incineration should be practical for these sources because low air volumes could be used to ventilate these sources.

This control measure is also directed at reducing the emissions from coating-type application equipment that is used for cleaning. These sources probably have solvent evaporation rates similar to photoresist application, but are currently not subject to abatement requirements. These sources could be abated in the same manner as negative photoresist applicators are. Another option would be to describe this equipment in a new category in Regulation 8-16, and require 90 percent abatement (the cold cleaner definition does not adequately describe this equipment and freeboard requirements are not an adequate control measure).

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. This control measure was assumed to reduce RHC emissions from affected sources by 80 to 90 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.06	.07
1997	.07	.08
2000	.07	.08

Costs of Control

A representative proposal for incineration of emissions from solvent stations, solvent spraying, and positive photoresist has been submitted in Application #5341 by VLSI. The capital costs for this installation were calculated to be $2500 per ton reduced, with operating costs of about $1500 per ton reduced. The total cost of control was roughly $4000 per ton of RHC reduced. These costs are believed to be representative of the typical costs associated with complying with this control measure.

Other Impacts

If additional control of RHC emissions by incinerators is needed as a result of this control measure, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

References

"Emissions from Semiconductor Manufacturing in the Bay Area", Steve Hill, BAAQMD, 1987.

BAAQMD New/Modified Permit Application #5341 for VLSI.

CM# A17: CONTROL OF EMISSIONS FROM HOUSEHOLD SOLVENT DISPOSAL

Background

This control measure would reduce RHC emissions by encouraging local agency programs for the proper disposal of RHC containing household wastes.

A variety of household products contain volatile organic compounds including consumer products such as furniture polish and pesticides, and architectural coatings such as stains and lacquers. Many of these products are improperly disposed of by household refuse collection services, leading ultimately to the release of at least a portion of the volatile organics to the atmosphere, either at transfer stations or, more predominantly, at landfills. Other household products, such as old house paints, are stored for such prolonged periods of time that their volatile components evaporate.

The RHC emissions from household products which are no longer useful can be reduced by proper handling and treatment/disposal methods which contain and recycle or destroy the organic compounds.

Regulatory History

The District does not specifically regulate RHC emissions from household products disposal. The disposal of many household products in landfills is, however, regulated through hazardous waste statutes, although compliance rates are believed to be low. Household hazardous waste disposal programs are currently in operation in much of the Bay Area. These programs which are generally sponsored by county governments are held periodically, most often with no direct costs for residents. Privately run hazardous waste disposal operations also exist, some of which will accept certain household wastes.

Emissions Subject to Control

A number of source categories are affected including most solvent-based structures coating and cleanup categories and certain consumer products categories. It was assumed that one percent of the emissions from these categories occurs do to improper disposal. The projected RHC emissions subject to control are given below. It should be noted that there may be significant overlap between this control measure and others being proposed. The emissions subject to control given below only incorporate the effectiveness of control measures already adopted. The emissions from some of the affected source categories are expected to decrease over time due to implementation of new control measures.

Year	Emissions Subject to Control (TPD, Summer)
1994	.24
1997	.24
2000	.25

Proposed Method of Control

Two actions should reduce emissions from household solvent disposal: (1) improved product labeling regarding proper disposal methods and, (2) encouragement of additional and improved local hazardous waste disposal programs. Product manufacturers can be encouraged or required to include instructions on the correct methods for storing, sealing, transporting and ultimately disposing of products. Municipalities can be encouraged to offer more frequent, more convenient, and more publicized hazardous waste disposal "drives".

Emission Reductions Expected

It was assumed that the RHC emissions from affected sources would be reduced by 90 percent by proper methods of disposal.

The estimates below show the emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions (TPD, Summer)
1994	.21
1997	.22
2000	.23

Costs of Control

The cost-effectiveness of this measure has not been quantified at this time.

Other Impacts

No adverse environmental impacts are expected as a result of this control measure. The measure would reduce improper and illegal hazardous waste disposal at sanitary landfills. Positive impacts on indoor air quality may result from more timely disposal of household products that are no longer useful.

References

None.

CM# A18: SUBSTITUTE SOLVENTS FOR SURFACE PREPARATION/CLEANUP OF SURFACE COATINGS

Background

This control measure would reduce RHC emissions by requiring the use of low VOC and/or low vapor pressure cleanup and surface preparation solvents, and by requiring improved handling procedures.

For most surface coating operations, organic solvents are used to clean and maintain application equipment, spray booths, and other materials used in the coating process. Solvents are also often used for preparing the surface of a substrate prior to coating, generally by wipe cleaning. Although the volume of solvent used for these purposes may often be small in comparison with the amount of solvent used in the coating process, emissions from cleanup operations are collectively quite significant.

Regulatory History

The District regulates emissions from cleanup solvents under Regulation 8, Rules 1 and 16. Sections 321, 322, and 323 of Rule 8-1 limit general cleanup solvent emissions by requiring solvent to be stored in closed containers and cleaning to be done in a manner that minimizes emissions. Regulation 8-16 contains specific operating requirements for solvent cleaning equipment such as cold cleaners and vapor degreasers. Neither rule limits the VOC content or volatility of cleaning solvents. This measure would apply to all surface coating operations and would most likely require amendments to the general provisions of Regulation 8, Rule 1, and to each source specific rule in Regulation 8.

The South Coast AQMD has adopted a similar control measure directed at reducing emissions from cleanup solvents in their 1989 AQMP revision (CM #88-A-11).

Emissions Subject to Control

The affected source categories are the cleanup solvent categories for all types of surface coating operations including architectural and industrial maintenance coating, and the various manufacturing industries. It should be noted that there is considerable overlap between this control measure and several of the others proposed. The emissions projected for future years are based only on those requirements that have already been adopted, and do not consider the effects of any proposed control measures. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	17.7
1997	18.9
2000	19.5

Proposed Method of Control

This control measure would achieve precursor organic emission reductions by requiring the use of low VOC or lower vapor pressure cleaning solvents. The South Coast AQMD currently requires the use of low VOC cleanup solvents for several industries. These requirements specify the use of cleanup solvents which have a composite vapor pressure of 45 mm Hg or a VOC content of 200 grams per liter, or lower. Preliminary analyses done by the South Coast AQMD indicate that existing solvent formulations could be used for other industrial cleaning applications.

In some instances, water-base solvent formulations can be substituted in place of conventional petroleum-base formulations. There are citrus-based, water-soluble cleaning agents in use that contain no volatile organic solvent. This control measure would encourage the use of these agents to the maximum extent possible.

Improved solvent handling procedures are also expected to reduce RHC emissions. There are no specific handling procedures outlined in this proposal.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 40 to 60 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	7.09	10.6
1997	7.57	11.4
2000	7.81	11.7

Costs of Controls

Some low VOC solvent formulations are currently available, but these products are generally more expensive than conventional formulations. Other solvents will need to be developed through research and development. The South Coast AQMD estimates the cost-effectiveness of low emissions cleanup solvent formulations to be $1,100 per ton of RHC reduced.

Improved handling procedures reduce solvent usage, and therefore, should result in a cost savings.

Other Impacts

A reduction in hazardous waste generation may result if suitable substitutes for organic solvents are identified. There is a possibility of an increase in the emissions of substances which may be toxic or deplete upper atmospheric ozone if organic solvents are reformulated

with non-precursor or "exempt" solvents. The District, however, may not allow these type of solvent substitutions.

References

South Coast Air Quality Management District, Substitute Solvents Used for Cleanup of Surface Coating, CM #88-A-11

CM# A19: ULTRA-LOW VOC COATINGS

Background

This control measure would reduce RHC emissions from surface coating operations to "near-zero" levels by substitution of volatile organic solvents in coatings with oil produced from the plant *Vernonia Galamensis*. Vernonia oil is a naturally occurring, epoxidized oil, with great potential to be a solvent substitute, reducing the VOC content of surface coatings to nearly zero. For some coating applications, radiation curable coatings, which also produce essentially zero RHC emissions, may be a more appropriate ultra-low VOC technology.

This control measure could be implemented into any surface coating rule of Regulation 8, as technology for that type of operation permits. The most likely surface coating regulations include Rule 3, Architectural Coatings; Rule 23, Flatwood Paneling and Wood Flat Stock; and Rule 32, Wood Furniture and Cabinet Coatings. Other surface coating regulations may be amenable to this measure if the technology is transferable.

Regulatory History

The District has traditionally implemented low VOC standards for coatings based upon projected (i.e. technology forcing) limits derived from knowledge of high solids and water based technology and with the cooperative efforts of coating formulators and resin manufacturers. These limits have been set according to the limitations and perceived needs of each substrate regulated, and altered to reflect availability of complying coatings. The existing limits of technology are as follows:

Architectural Coatings

General Limitation	250 g/l; current
Specialty Limits:	
Below Ground Wood Preserv.	350 g/l; 9/1/92
Clear Wood Lacquer	350 g/l; 9/1/92
Clear Wood Sanding Sealer	350 g/l; 9/1/92
Clear Wood Varnish	350 g/l; current
Graphic Arts Coatings	500 g/l; current
Opaque Stains	350 g/l; current
Opaque Wood Preservatives	350 g/l; current
Primers, Sealers, Undercoat.	350 g/l; current
Roof Coatings	300 g/l; current
Semi-transparent Stains	350 g/l; current
Semi-trans, Clr Wood Preserv.	350 g/l; current
Clear Shellac	730 g/l; current
Pigmented Shellac	550 g/l; current
Waterproofing Sealers	400 g/l; current

Wood Furniture and Cabinet Coatings

Current Technology:	
Clear Topcoats	680 g/l
Sanding Sealer	680 g/l
Washcoat	740 g/l
Pigmented Coating	600 g/l

Wood Furniture and Cabinet Coatings (cont.)

Semi-transparent Stain	800 g/l
Opaque Stain	570 g/l

Proposed Limits:	
Clear Topcoats	275 g/l; 7/1/94
Sanding Sealer	275 g/l; 7/1/96
Washcoat	120 g/l; 7/1/96
Pigmented Coating	275 g/l; 7/1/94
Semi-transparent Stain	120 g/l; 7/1/96
Opaque Stain	240 g/l; 7/1/96

Emissions Subject to Control

The affected source categories were assumed to be the various solvent-based architectural coating categories, *wood furniture and cabinet coating*, and *flat wood paneling coating*. Cleanup solvent categories were not included, although the emissions from these categories may also be reduced by this control measure. The projected RHC emissions from the affected categories are listed below.

It should be noted that there may be significant overlap between this control measure and others being proposed. The emissions subject to control given below only incorporate the effectiveness of control measures already adopted. The emissions from some of the affected source categories are expected to decrease over time due to implementation of new control measures.

Year	Emissions Subject to Control (TPD, Summer)
1994	21.3
1997	22.4
2000	23.1

Proposed Method of Control

This control measure is derived from the South Coast AQMD Technology Advancement Office's (TAO) S-15 Project, cosponsored by the Paint Research Associates, the State of Michigan and the U.S. Agency for International Development. It involves the substitution of photochemically reactive solvents in coatings with oil produced from the plant *Vernonia Galamensis*. Vernonia oil is a naturally occurring, epoxidized oil, with great potential to be a solvent substitute, reducing the VOC content of architectural and wood furniture coatings to nearly zero. The oil will reduce the VOC content of typical formulas based predominantly on the properties of linolenic or other fast drying, unsaturated acids, developing coatings with high solids, alkyd and epoxy ester formulations.

The S-15 project intends to compare drying times and viscosities of conventional paint formulations with Vernonia diluents. For instance, it is projected that nitrocellulose lacquer, currently containing 680 g/l VOC could have less than 100 g/l VOC if it substituted Vernonia oil. The potential for directly applying Vernonia oil for preparation of solvent-less coatings and different dryer systems is also being evaluated. Vernonia oil produces no VOC emissions. So far, all blends of Vernonia reactive diluents with saturated and unsaturated acids appear to be compatible with alkyds; these blends can produce homogeneous paint formulations and high quality coatings.

Radiation curable coatings are high solids formulations which contain little or no organic solvents. These coatings use ultraviolet or electron beam energy to initiate the reaction to form a polymer surface coating. Radiation curable coatings, because of their high viscosity and need for control of coating thickness, are most amenable to flat stock roll coatings applications. Improvements in engineering have also allowed the application of radiation curable coatings on a three-dimensional basis.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Each of the categories of coatings listed above could be reduced to at least 100 g/l VOC. It was assumed that the RHC emissions from the affected categories would be reduced by 90 to 95 percent due to this control measure.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	19.2	20.2
1997	20.2	21.3
2000	20.7	21.9

Costs of Control

Vernonia is projected to have excellent potential for commercialization, however no cost data are available at this time. Future South Coast TAO projects may focus on new methods for growing *Vernonia Galamensis* in the United States and the development of more cost-effective methods of extracting oil from the seeds.

According to EPA, the applied cost of radiation curable coatings is only slightly higher than for conventional solvent coatings, for the same area of coverage. If the operating costs associated with abatement equipment for conventional coating systems are considered, a cost differential in favor of radiation curable materials may actually result.

Other Impacts

Should methods of growing Vernonia in the U.S. be developed, this could be a major cash crop requiring agriculture zoned land to cultivate, adding to already competing pressures for land use.

Radiation curable coating systems use 75 to 90 percent less energy than conventional thermal curing systems. Available data indicate that some monomer emissions would be present in the exhaust for processes using radiation curable coatings, although further study is needed to better define potential toxic air contaminant problems.

References

South Coast Air Quality Management District, Technology Advancement Office, Annual Report, August 1990.

Draft Evaluation of Radiation-Curable Coatings as a Technology for Reducing VOC Emissions from Surface Coating Operations, EPA Control Technology Center, January 1991.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

B. FUELS/ORGANIC LIQUIDS STORAGE AND DISTRIBUTION

CM# B1: CONTROL OF EMISSIONS FROM RAILCAR LOADING

Background

This control measure would reduce RHC emissions from the loading of organic liquids into railcars by establishing vapor recovery requirements. The measure would most likely apply only to organic liquids of a specified volatility (e.g. true vapor pressure greater than 0.5 psia).

Loading losses occur from railcars as the organic vapors in the empty cargo tanks are displaced to the atmosphere by the liquid being loaded into the tanks. The method of loading and the loading history of the tank are both important factors in the quantity of emissions which result from railcar loading.

The number of facilities that would be affected by this control measure and the quantity of organic liquids loaded into railcars within the District are currently unknown.

Regulatory History

The District currently regulates the off-loading of railcars into stationary tanks. There are no District requirements for Phase I controls during the loading of railcars.

Emissions Subject to Control

The emissions from railcar loading operations have not been quantified due to insufficient information.

Proposed Method of Control

This control measure would require the design and installation of a vapor balance system to control the VOC emissions during railcar loading operations. As the railcar is loaded, the headspace vapors would be displaced either directly into a vapor processing unit or into an intermediate vapor storage tank. Appropriate control technology available for vapor processing include refrigeration, carbon adsorption, or thermal oxidation.

Emission Reductions Expected

RHC emission reductions of 80 to 90 percent are expected from affected sources. Because the emissions from railcar loading operations have not been quantified, however, the total emission reductions from this control measure are unknown at this time.

Costs of Control

The costs of the vapor collection system would be minimal, consisting of plumbing and piping capable of capturing the displaced vapors as the railcar is loaded. The major expense would be at those facilities without an existing vapor processing system. It is anticipated that most of the facilities affected by this control measure have existing vapor processing equipment that could be used for abating the emissions from railcar loading.

The exact costs for the processing equipment will depend upon the control technology selected and the required capacities. Typical capital costs for processing equipment should range between $200,000 and $800,000 per installation. The average cost-effectiveness of this control measure is estimated to be roughly $4000 per ton reduced.

Other Impacts

Where RHC emissions are controlled by incinerators, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

References

None.

CM# B2: IMPROVED STORAGE OF ORGANIC LIQUIDS RULE

Background

This measure would reduce RHC emissions from organic liquid storage tanks by setting more stringent requirements for certain fixed and floating roof tanks. The measure is primarily directed at tanks storing organic liquids at petroleum refineries, chemical plants and bulk distribution facilities.

RHC emissions from fixed roof tanks include both breathing and working losses. Breathing losses stem from vapor expansion and contraction which result from changes in temperature and barometric pressure. Working losses include the combined emissions from tank filling and emptying. External or internal floating roof tank emission sources may include rim seal, withdrawal, deck fitting, and deck seam losses.

This control measure would affect petroleum refining facilities, chemical manufacturing plants, and possibly some bulk transfer and storage facilities. Some other industries which consume or produce significant amounts of organic liquids may also be affected to some degree.

Regulatory History

The District regulates emissions from the storage of organic liquids under Regulation 8, Rule 5. Rule 8-5 was originally adopted in 1978 and has been amended a number of times, most recently in 1988. Presently, organic liquids with Reid vapor pressures greater than 0.5 psia are subject to this Rule.

The standards for storage tanks are dependent on tank size and the volatility of the material stored. All tanks less than 260 gallons capacity, and some grandfathered tanks less than 2000 gallons capacity are currently exempt from Rule 8-5. Tanks larger than 20,000 gallons capacity that store liquids with Reid vapor pressures greater than 1.5 psia must be equipped with a vapor loss control device. The same requirement is applicable for tanks larger than 40,000 gallons capacity that store liquids with Reid vapor pressures greater than 0.5 psia. The required vapor loss control device may consist of a floating roof tank which meets specified criteria, a vapor recovery system, or another device which provides equivalent emission reductions.

Rule 8-5 requires periodic inspections of floating roof tank seals. Some modest requirements also exist for the removal of tanks from service during tank cleaning and repairs. No tank color requirements currently exist in Rule 8-5.

Emissions Subject to Control

The affected source categories are *petroleum refinery cone roof* and *floating roof storage tanks*, *other organic compounds evaporation -- storage tanks*, and *bulk plant breathing and working losses*. Only a portion of the total emissions in each of these categories was considered subject to this control measure. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	2.11
1997	2.17
2000	2.24

Proposed Method of Control

A number of control options are being considered for further controlling emissions from storage tanks as listed below.

(1) Require more liquids presently stored in cone roof tanks to be stored in floating roof tanks, or to be controlled by vapor recovery. This could be accomplished by lowering the tank size and/or vapor pressure cut-offs in Rule 8-5.

(2) Lower or replace the existing small tank exemption with a throughput exemption. This would subject small tanks which have significant throughputs to control requirements.

(3) Require floating roof tanks that fail to comply to undergo more frequent tank seal inspections. Consider increasing tank seal inspection frequencies for other tanks, as well.

(4) Require floating roof tanks to use the best type of primary and secondary seal and to improve fitting designs.

(5) Establish tank color requirements for certain large above ground storage tanks.

(6) Require vapor recovery for certain new tanks. Presently, floating roof tanks are not allowed for tanks holding liquids with a Reid vapor pressure exceeding 11 psia. The vapor pressure cut-off for vapor recovery could be reduced to 4 psia, or another suitable value.

(7) Require a compliance-based floating roof tank vapor recovery retrofit, whereby floating roof tanks receiving a specified number of violation notices would be required to be abated by vapor recovery within a specified timeframe.

(8) Require control of tank cleaning emissions. This is going to be required in the South Coast under their Rule 1149 on tank degassing. The South Coast AQMD assumed either carbon adsorption, refrigeration, incineration, or other adsorption technique would be used, and estimated about 3000 pounds of RHC reduction per tank cleaning.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. The various controls are expected to be implemented over a period of several years. RHC emissions were assumed to ultimately be reduced by 50 to 60 percent from affected cone roof tanks, and by 30 to 40 percent from affected floating roof tanks.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	1.01	1.22
1997	1.04	1.26
2000	1.07	1.30

Costs of Controls

The average cost-effectiveness of the various control options listed above is estimated to be about $2000 per ton reduced. A more detailed discussion of costs for some of the individual options is given below.

(1) Converting a fixed roof to a floating roof tank is estimated to cost about $125,000 for a 40,000 bbl tank. The cost-effectiveness of this measure is estimated to be roughly $1300 per ton of RHC reduced.

(2) The costs of replacing a seal with an improved version are assumed to average about $45,000 per tank. There are no additional operation and maintenance costs, above those which are presently required. If the tank must be emptied and cleaned out first, this cost will be higher if not done concurrently with routine tank cleaning. The cost-effectiveness of this measure is estimated to be roughly $500 per ton of RHC reduced.

(3) The cost for installing vapor recovery on a 120,000 bbl floating roof tank is $323,000 to convert to an internal floating roof tank plus perhaps an additional $25,000 for a scrubbing system. The operating costs for the scrubber are should be about $2000 per year. Any cost due to improved compliance with existing rules should not be an additional cost for tank users because it is an expense that they should already have. The cost-effectiveness for vapor recovery retrofits is estimated to be about $3000 per ton reduced.

(4) The South Coast AQMD estimates $4,000 to $20,000 per ton reduced for the cost of controlling tank degassing, depending on the tank size.

Other Impacts

This control measure will reduce odorous emissions and reduce the emissions of benzene, a toxic air contaminant. There will also be less product losses.

References

Staff Report for Proposed Rule 1149, October 23, 1987, SCAQMD.

Private communications between Harold Lips and Pacific Refining on tank seal costs, April 30, 1990.

Oil and Gas Journal, "Geodesic-Dome Tank Roof Cuts Water Contamination, Vapor Losses", A.E. Barrett, July 10, 1990.

OAQPS Control Cost Manual, PB90-169954, Jan, 90.

CM# B3: IMPROVED ORGANIC CHEMICAL TERMINAL AND BULK PLANT RULE

Background

This control measure would reduce RHC emissions from non-gasoline bulk plant operations by modifying the exemption criteria and by lowering the existing emission limitation.

Non-gasoline terminals and bulk plants are facilities in which liquid organic chemicals are received, stored in stationary tanks, and loaded into tank trucks or other cargo carriers for delivery to other plants or distribution points. RHC emissions occur from loading and unloading operations, and from storage tanks.

The majority of the organic compounds stored and transferred at bulk plants currently meet an existing volatility exemption, and therefore are not subject to vapor recovery requirements.

Regulatory History

The District regulates emissions from organic chemical terminals and bulk plants under Regulation 8, Rule 6. Rule 8-6 currently requires bulk loading operations of non-gasoline organic liquids with a true vapor pressure over 1.5 psia to have a suitable vapor recovery system. The current emission limitation for a mandated vapor recovery system is 0.65 pounds of RHC emission per 1,000 gallons of product loaded.

Emissions Subject to Control

A specific source category currently does not exist for organic liquid terminals and bulk plants. The emissions from these sources are contained in the category *organics evaporation -- other*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.45
1997	.47
2000	.49

Proposed Method of Control

It is proposed to reduce the vapor pressure exemption of Rule 8-6, thereby subjecting a larger number of organic liquids to vapor recovery requirements. Reducing the exemption cut-off to a true vapor pressure of 0.5 psia would greatly increase the number of chemicals that would have to meet the vapor recovery requirement.

This control measure also proposes to reduce the emission limitation to reflect recent advances in control technology. A more suitable emission limit would be 0.50 pounds of RHC per 1,000 gallons of product loaded. This would match the latest changes made in Rule 8-39 for gasoline bulk plants, made on October 7, 1987.

The affected facilities could implement existing technology currently used at gasoline bulk terminals to comply with this control measure. Typical control technologies are vapor balance, carbon adsorption, thermal incineration, and refrigeration.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 40 to 60 percent from affected sources.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.18	.27
1997	.19	.28
2000	.20	.30

Costs of Control

For those facilities without existing control devices, the costs will include both a collection and vapor processing system. The control costs will vary greatly depending upon the selected control technology. Vapor balance would be the least expensive followed by thermal incineration, carbon adsorption, and refrigeration. Capital costs for vapor processing systems are estimated to be between $175,000 and $350,000 per facility. It is expected, however, that in most cases the costs of control will be completely offset by product recovery credits. This has been demonstrated to be true for gasoline bulk plant vapor recovery systems.

Other Impacts

Where RHC emissions are controlled by incinerators, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

Positive impacts include product recovery and possibly decreased emissions of toxic air contaminants.

References

None.

CM# B4: FURTHER EMISSION REDUCTIONS FROM GASOLINE DELIVERY VEHICLES

Background

This control measure would reduce RHC emissions from gasoline delivery vehicles loading at bulk terminals and controlled bulk plants by setting more stringent performance requirements for vapor recovery components. Under existing State code, the California Air Resources Board (CARB) would need to implement this measure for the State of California.

There are approximately 4,200 CARB-certified gasoline cargo tanks in California. In calender year 1989, there were approximately 1,830 cargo tank loadings per day at gasoline bulk terminals in the Bay Area.

In 1986, the District received certification, from CARB, for a pressure decay test method to be used for compliance determination of cargo tanks. This test method is currently the only accurate in-field method for determining the status of the cargo tank vapor vent valves.

Regulatory History

Section 41962(h) of the California Health and Safety Code (CH&SC) states: "Performance standards of any district for cargo tank vapor recovery on tank vehicles used to transport gasoline shall be identical with those adopted by the state board therefor and no district shall adopt test procedures for, or require certification of, cargo tank vapor recovery systems".

On April 18, 1977, CARB adopted "Certification and Test Procedures for Vapor Recovery Systems of Gasoline Delivery Vehicles" (Method 2-5). These certification procedures were subsequently amended on September 1, 1982, and February 24, 1984. Current standards for gasoline cargo tanks include: (1) annual certification and year-round criteria for pressure decay and, (2) criteria for the pressure increase past the cargo tank vapor vent valve.

On September 1, 1982, CARB adopted "Test Procedures for Gasoline Vapor Leak Detection Using Combustible Gas Detectors". This indirect correlation of a hydrocarbon concentration to the pressure decay standards was the only allowed test procedure for determining compliance with the year-round pressure decay standards for gasoline cargo tanks. This procedure cannot, however, be used to quantify the pressure increase past the vapor vent valve(s).

In 1985, the District's Source Test Section developed a new test procedure that accurately quantifies both the pressure decay from the cargo tank and the pressure increase past the vapor vent valve. The District submitted this method (Source Test Procedure ST-33) to CARB on July 25, 1985, and it was approved as an alternate method (pursuant to Section 41962 of the CH&SC) on January 27, 1986 (see CARB Executive Order G-70-106).

The current State year-round standards for gasoline cargo tanks are as follows:

Cargo Tank Capacity, Gallons	Allowable Pressure Decay in 5 Minutes, inches W.C.
>2,500	2.5
1,500-2,499	3.0
1,000-1,499	3.5
0-999	4.0

The corresponding CARB certification pressure decays are 1.0, 1.5, 2.0, and 2.5 inches w.c., respectively.

The internal vapor valve must be maintained to meet the following requirement: A pressure increase of no more than five inches of water (gauge) shall occur in five minutes when the delivery tank is pressurized to 18 inches of water (gauge) according to the procedures in Section IX-E.

Emissions Subject to Control

The affected source category is *fuels distribution -- trucking*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.17
1997	.17
2000	.17

Proposed Method of Control

The proposed method of control is a two-phase strategy. First, it is necessary to replace the 13 year-old decay standards. State-of-the-art advancements in cargo tank domes, P/V valves, and gasketing material have made the existing standards obsolete. After reviewing a large number of cargo tank certification tests, the following Table should be submitted to CARB for workshop and adoption:

Cargo Tank Capacity, Gallons	Allowable Pressure Decay in 5 Minutes, inches W.C.: Annual Certification	Year-Round
> 2,500	0.5	1.5
1,500-2,499	1.0	2.0
1,000-1,499	1.5	2.5
0 - 999	2.0	3.0

The second phase of control is to have CARB rewrite the vapor vent valve portion of Method 2-5 to specify that a pressure decay test method shall be used to determine year-

round compliance of the vapor vent valves. This will also require CARB to adopt an appropriate pressure decay test method.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 30 to 40 percent from the affected source category.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.05	.07
1997	.05	.07
2000	.05	.07

Cost of Control

The costs of this control measure would be minimal. Once the appropriate repairs to the cargo tanks have been made, the equipment can be kept in compliance during their preventative maintenance inspections. The largest capital expenditure will be for those cargo tanks with internal vapor vent valves which cannot, due to design, meet the vapor vent valve standard. The average cost per vehicle is estimated to be about $360 per year. It is expected that, in most cases, the costs of this control measure will be completely offset by product recovery.

Other Impacts

There should be no adverse environmental impacts as a result of this measure. There will be a fire safety advantage due to the reduced vapor leaks both while in transit and upon arrival at the gasoline dispensing facility. There will also be a substantial reduction of VOC emissions during cargo tank transit operations. Because the benzene concentration of the headspace vapors is approximately 2,900 ppm, there will also be a reduction in the emissions of this toxic air contaminant.

References

CARB Method 2-5,"Certification and Test Procedures for Vapor Recovery Systems of Gasoline Delivery Vehicles", Amended February 24, 1984.

CARB Test Procedure, "Test Procedure for Gasoline Vapor Leak Detection Using Combustible Gas Detector", Adopted September 1, 1982.

Interoffice Memo from Ken Kunaniec to Gale Karels, 1986.

"A Test Method for the Pressure Integrity of Gasoline Cargo Tanks", BAAQMD, K.M. Kunaniec, G.G. Karels, D.A. Levaggi.

CM# B5: LIMITATIONS ON MARINE VESSEL TANK PURGING

Background

This control measure would reduce RHC emissions from marine vessel housekeeping and ballasting operations. Emissions from these sources could be reduced by control devices or, in some cases, by delaying these operations until the vessel is outside of a specified zone to ensure that the emissions would not have an impact on the District's air quality.

Meteorological conditions along the coast of the District are such that offshore emissions are carried onshore most of the time, particularly during the summer ozone season. A number of petroleum tank vessel operations result in the emissions of reactive organic gases. Stringent requirements already exist to control RHC emissions from marine vessel loading and lightering operations. The specific operations addressed by this control measure are housekeeping and ballasting operations.

Housekeeping emissions result from altering the composition of gases contained within cargo tanks by tank washing, gas freeing, and/or purging. Shipping representatives have indicated that ships leaving the District routinely gas free their cargo holds. Ballasting emissions occur when vapors in a cargo tank are displaced into the atmosphere by incoming ballast water.

Regulatory History

The District has adopted two rules to reduce RHC emissions from marine tank vessels. These rules limit emissions when tanks are being filled at a marine terminal, and when tanks are being filled during a lightering operation. The District currently does not have any specific requirements relating to marine vessel housekeeping or ballasting operations.

The District has primary legal authority to regulate marine vessel emissions which affect onshore air quality. That authority is subject to limitation only if federal law specifically preempts the District, or if State or local regulations would result in a direct unconstitutional burden on interstate or international commerce.

Coast Guard regulations currently limit RHC emissions from ballasting operations for certain tankers in areas where federal ozone ambient air quality standards are exceeded. However, several classes of tankers are exempt from these regulations and are allowed to vent cargo vapors while ballasting.

The South Coast AQMD has adopted a control measure proposing to control housekeeping and ballasting emissions in their 1989 AQMP revision (CM #88-I-3).

Emissions Subject To Control

The affected source categories are *marine vessel cleaning and gas freeing*, and *ballasting*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	1.43
1997	1.48
2000	1.52

Proposed Method Of Control

Emissions from housekeeping operations could be controlled by directing the vapors to control devices (e.g., refrigeration, absorption, adsorption, or incineration) on board the vessel or on shore mounted units, or by delaying these operations until the vessel is outside of a specified zone to ensure that the emissions would not have an impact on the District's air quality.

Onshore or shipboard control devices may also be used to control emissions from ballasting operations. In addition, operational modifications may be used to reduce emissions from ballasting. For example, dedicated ballasting involves the use of certain tanks to carry only ballast water. Compression ballasting involves taking on water with all vents to the atmosphere closed. Ballast water can be taken up to the set point of the tank pressure/vacuum valves. The compressed vapors are retained until the vessel leaves coastal waters.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that this control measure would reduce affected emissions by 90 to 95 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	1.29	1.36
1997	1.33	1.40
2000	1.37	1.44

Costs of Control

The costs of control depend on a number of factors including the control methods used, the volatility of the prior cargo, the remaining cargo quantity, the size of the tank vessel, and the amount of time required to commute between regulated and unregulated boundaries.

Vessels employing on-board controls would incur little additional costs to control housekeeping and ballasting emissions. Vessels able to tie up to on-shore controls may also be able to incur little additional costs, because most terminals will soon have on-shore control systems.

Vessels not employing controls, and opting to conduct housekeeping operations outside the California Coastal Region prior to returning to the District would likely incur abatement costs of up to $4200 per ton of RHC reduced, according to the South Coast AQMD. Vessels not employing controls and opting to conduct housekeeping operations outside the California Coastal Region while enroute to Valdez and/or other ports of call would not incur additional costs, but would only have to hold the vapors a little while longer before purging.

Other Impacts

Where RHC emissions are controlled by incinerators, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

A reduction in the emissions of benzene, a toxic air contaminant, will result from this control measure. Positive water quality impacts should also result to the extent that ballasting in cargo tanks is reduced.

References

SCAQMD 1989 AQMP Revision, CM #88-I-3.

CM# B6: CONTROL OF EMISSIONS FROM CLEANING-UP ORGANIC LIQUIDS

Background

This control measure would reduce RHC emissions from vacuum trucks that clean up hydrocarbon spills, and from equipment that is used to clean out gasoline storage tanks, tank trucks, and railcars that previously handled gasoline or other organic liquids. Emissions from these operations can be controlled with portable carbon adsorption systems.

Liquid spills at industrial facilities or roadways are often cleaned up using a vacuum truck to suck up the liquid into the truck's storage tank. As the liquid fills the storage tank, organic vapors that are contained in the vapor space of the storage tank are displaced to the atmosphere.

A similar procedure is used to clean out storage tanks, truck tanks, and railcars that usually store organic liquids. Before doing repair work on a tank or when taking a tank out of service, all of the organic liquid must be removed from the tank. This is usually accomplished by washing the tank with water or some other cleaning solution. The used water or cleaning solution, along with organic contaminants, is then pumped from the tank to a mobile tank truck or some other cleaning device. The liquid phase material is handled using conventional wastewater treatment methods. However, the vapors that are displaced from the truck tanks are emitted to the atmosphere.

Regulatory History

The District currently does not have a specific rule directed at reducing the RHC emissions from cleanup vehicles or tank cleaning equipment. These sources are subject to Regulation 8, Rule 2, Miscellaneous Operations.

District Regulation 8, Rule 9, Vacuum Producing Systems, requires that the vents from vacuum producing systems at petroleum refineries and chemical plants be controlled, although a required control efficiency is not listed. Vacuum tank trucks are specifically exempted from Rule 8-9.

Emissions Subject to Control

The emissions subject to control for this control measure have not been quantified at this time.

Proposed Method of Control

This control measure proposes to reduce RHC emissions that are generated from organic liquid spills and tank cleanup operations. These organic vapors could be ducted from the cleanup tank vent opening to a control device such as a carbon adsorption system. The carbon system would have to be mounted on the truck or tank cleaning equipment because of the mobile nature of these operations. Carbon canisters could be used which are very portable. Drum-sized carbon canisters typically contain about 150 pounds of carbon. When spent, these canisters can be regenerated or disposed of, as economic factors dictate. The truck operator may require a VOA instrument to show that there is no breakthrough of

the carbon during operation. RHC emissions could be reduced by 95 percent using a portable carbon adsorption system.

Emission Reductions Expected

The types of abatement devices that are expected to be used for reducing RHC emissions typically have control efficiencies in excess of 95 percent. Because the emissions subject to control have not yet been quantified, however, emission reduction estimates are currently not available.

Costs of Controls

The costs of control would depend on the type of organic materials being cleaned up, the frequency of spills, the quantity of liquid involved in the spill, and other factors. Costs were estimated assuming that drum sized carbon canisters would be mounted on the cleanup vehicle and when spent, the canisters would be disposed of, rather than regenerated. Cost estimates were calculated in accordance with the method outlined in an EPA Control Costs Manual. The costs of purchase, transportation and disposal, are estimated to be approximately $800 for each canister used. Assuming that a 150 pound carbon canister can collect 25 percent of its weight in organic compounds, the cost-effectiveness of this control measure would be: $\$800 / [(150 \text{ pounds}) (0.25)/(2000 \text{ lb/ton})] = \$42,000$ per ton of RHC reduced. The costs of a regenerable system that is frequently used is expected to be far less.

Other Impacts

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

Positive impacts of this control measure include a reduction in the emissions of benzene, a toxic air contaminant.

References

United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Control Costs Manual, Fourth Edition, January, 1990, No. PB90-169954.

CM# B7: CONTROL OF EMISSIONS FROM PROPANE HANDLING

Background

This control measure would reduce RHC emissions by eliminating uncontrolled gas venting during LPG fuel transfers, and by banning uncontrolled venting during servicing of larger tanks.

During some LPG gas transfers, RHC emissions occur when the receiving tank is vented to the atmosphere. The installation of a bleed-off gas recovery device would reduce emissions of LPG which consists primarily of propane, butane, propylene and butylene.

This control measure would affect most commercial LP-gas distributors located within the District.

Regulatory History

Currently the District does not regulate emissions from the transfer of LPG. At this time, there are also no federal or State requirements.

Emissions Subject to Control

LPG fuel transfers are currently not covered under a specific source category, and the emissions from these sources are unknown at this time.

Proposed Method of Control

In large scale operations, significant RHC emissions do not occur during LPG tank transfers because LPG is unloaded from delivery tanks to storage tanks through a closed system under pressure by means of a liquid pump or a gas compressor. When a liquid pump is used, connections are made between the liquid outlet of the delivery tank and the liquid inlet of the storage system as well as a similar connection for the vapor head space in both vessels. During transfer, pressure equalization is achieved between the vessels via the vapor connections. If a gas compressor is used, vapor head space taken from the storage tank can be discharged into the vapor space of the delivery tank. The result is be to create a pressure differential between the tanks and force the liquid from the delivery tank to the storage tank.

These large scale commercial techniques could be applied to medium or small users with good results. Smaller users could possibly adapt their existing equipment by use of a compressor attached to their bleed-off valve. During routine transfer operations, the amount of LPG that would normally be vented to the atmosphere could now be recondensed and pumped back into the storage tank.

A possible alternative method of control would be to abate the bleed-off valve emissions with an emission control device, such as a Hirt-type incineration system (frequently used at gasoline dispensing facilities). A carbon adsorption system could also be attached to the bleed-off valve to control LPG emissions.

Emission Reductions Expected

RHC emission reductions of 80 to 90 percent are expected from affected sources. Because the emissions from LPG fuel transfer operations have not been quantified, however, the total emission reductions from this control measure are unknown at this time.

Costs of Control

Purchase and installation costs for this control measure vary widely depending on the method of RHC abatement chosen. A compressor-type system would best accommodate most medium and small users with an initial installation cost of under $1,000.

A more elaborate system like the Hirt System would have initial installation costs of up to $10,000. If this system were installed at a GDF site, it could serve the dual purpose of LPG abatement and meeting Phase II requirements.

Due to uncertainties regarding the emission reductions associated with this control measure, the cost-effectiveness is considered unknown at this time.

Other Impacts

No adverse environmental impacts are expected as a result of this control measure, although the use of gas compressors will have some negative energy impacts.

References

Gas Engineers Handbook, Industrial Press Inc., Section 514.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

C. REFINERY AND CHEMICAL PLANT PROCESSES

CM# C1: IMPROVED PRESSURE RELIEF VALVES AT REFINERIES AND CHEMICAL PLANTS RULE

Background

This measure would reduce RHC emissions from pressure relief valves at chemical plants and refineries by requiring rupture disks with tell-tale indicators, or venting to an abatement device.

Pressure relief valves are automatic pressure relieving devices used on equipment handling organic compounds. These valves are actuated when upstream static pressure reaches a set-point, unsafe level.

This control measure would affect pressure relief valves at petroleum refineries and chemical manufacturing plants, but does not apply to P/V valves used on storage tanks.

Regulatory History

The District regulates the emissions of precursor organics from pressure relief valves at refineries and chemical plants under Regulation 8, Rule 28. Rule 8-28 contains standards for pressure relief valves that are found to be leaking with a portable hydrocarbon detector. The measured leak rate at which action must be taken is 10,000 ppm. If leaking, the relief valve leak must be minimized and the relief valve repaired at the next turnaround.

Presently, Rule 8-28 requires that relief valves be inspected quarterly, unless the valve is inaccessible and then it is to be inspected annually. Inspection requirements were not added to Rule 8-28 until 1989; most affected facilities are presently going through their first round of required inspections.

Emissions Subject to Control

The affected source category for refineries is *fugitives -- pressure relief valves*. For chemical plants, relief valve emissions are included within the category *fugitives (all mfg.) -- valves and flanges*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.58
1997	.60
2000	.62

Proposed Method of Control

Relief valves can be prevented from leaking by venting to a control device, or by installing rupture disks ahead of the relief valve. The typical control device used is a flare, but other systems can be used. If a rupture disk is used, in order to be effective, it should include a tell-tale indicator so that the operator can determine if a rupture has occurred.

Lowering the level at which a leak is considered may increase the effectiveness of this control measure. EPA is proposing a level of 500 ppm for pressure relief valves at chemical plants with no decision yet on refineries. The South Coast AQMD now requires a leak level of 200 ppm. The South Coast AQMD estimates a leak level of 200 ppm would result in an 80 percent reduction from the present estimated emission levels for relief valves (the District, however, does not yet have the emissions data on relief valves in the Bay Area to confirm these emission reduction estimates). The District is considering the feasibility of a 100 ppm leak definition.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 60 to 80 percent from the affected source categories.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.35	.47
1997	.36	.48
2000	.37	.49

Costs of Controls

The costs of this control measure are not well defined because the number of leaking valves at the affected facilities is presently unclear. Installing a rupture disk is usually a lower cost than venting to a flare because of the additional cost of piping required for tying into the flare header. Also, as additional loads to the flare are made, flare capacity is consumed and, eventually, a new flare system may be required.

A cost of $5000 per relief valve needing repair is believed to be typical. This cost estimate includes labor and design, and the addition of the rupture disk or the re-routing of the vent line. The overall cost-effectiveness of this control measure is estimated to be roughly $10,000 per ton of RHC reduced.

Other Impacts

This control measure will reduce emissions of benzene, a toxic air contaminant, as well as lower the amount of odorous emissions. There will also be less product loss resulting in more efficient refinery and chemical plant operations.

Where RHC emissions are controlled by incineration, emissions of CO and NOx may result. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of fuels in the thermal oxidation abatement devices.

References

Staff Report for Proposed Rule 1173, May 17, 1989, SCAQMD.

CM# C2: IMPROVED PUMP AND COMPRESSOR SEALS AT REFINERIES AND CHEMICAL PLANTS RULE

Background

This control measure would reduce RHC emissions from pumps and compressors at refineries, chemical plants, and bulk distribution facilities by requiring improved seals.

Pumps and compressors are used for moving liquids and gases within a process unit or piping system. Pumps and compressors in hydrocarbon service can have fugitive emissions of organic compounds due to leaking seals. Advances in seal technology have resulted in pumps and compressors with significantly reduced fugitive emissions.

Regulatory History

The District regulates the emissions of precursor organics from pumps and compressors at refineries and chemical plants under Regulation 8, Rule 25. Rule 8-25 requires that, if the concentration of organics at a distance of one-centimeter or less from the pump or compressor is greater than 10,000 ppm, the leak must be repaired immediately, or minimized and repaired by the next turnaround if the equipment is considered essential. Presently, Rule 8-25 requires that pumps and compressors be inspected quarterly. In September 1989, the inspection frequency was changed to quarterly from once per year, and the low vapor pressure exemption was changed to a cutoff point of 0.05 psia at 20° C.

Emissions Subject to Control

The affected source category for refineries is *fugitives -- pump and compressor seals*. For chemical plants, the affected emissions are included within the category *fugitives (all mfg.) -- valves and flanges*. The projected emissions subject to control are given below. These estimates represent emissions from those sources that would need to replace seals.

Year	Emissions Subject to Control (TPD, Summer)
1994	1.04
1997	1.07
2000	1.10

Proposed Method of Control

This control measure would require the replacement of older pumps and compressors which leak with equipment with "leakless" or other advanced design. Mechanical seal vendors appear to be willing to guarantee 1000 ppm leak-levels and data from the refineries show that at least 90 percent of the affected equipment already meets this limit. Data from a seal testing laboratory shows emission levels as low as 100 ppm for single mechanical seals. Retrofit installation of these seals on existing pumps should allow levels of 500 ppm and, in many cases, 100 ppm to be achieved. Where single mechanical seals cannot be used, there are other alternative technologies including double mechanical seals, tandem mechanical seals, magnetic drive pumps, or canned pumps. When properly maintained, the alternative

mechanical seals can achieve nearly unmeasurable emissions, while the magnetic drive and canned pumps have emissions that are unmeasurable.

EPA is proposing a leak-level of 1000 ppm for pumps at chemical plants with no decision yet on refineries. The South Coast now requires a leak-level of 1000 ppm. Requiring a leak-level of 100 ppm would result in a 80 to 90 percent reduction from the present estimated fugitive emission levels for pumps. This estimate is based on data supplied by Exxon and Unocal and the SOCMI study emission factors.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 80 to 90 percent for affected sources.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.83	.93
1997	.86	.96
2000	.88	.99

Costs of Controls

Assuming that pumps and compressors can achieve lower emission levels by adding improved single mechanical seals, the costs would be about $2000 per leaking pump. This estimate is based on vendor information. The labor needed to make these changes is probably about 5 hours. If tandem, double, magnetic drive, or canned pumps are used, the capital costs will be higher. It is estimated that about 20 percent of existing equipment will require new seals.

Because pumps need to be maintained on a periodic basis, there should be no additional operation and maintenance costs associated with this control measure. The overall cost-effectiveness of this control measure is estimated to be roughly $2000 per ton of RHC reduced.

Other Impacts

This control measures will reduce emissions of benzene, a toxic air contaminant, as well as lower the amount of odorous emissions. There will also be less product loss resulting in more efficient refinery and chemical plant operation. Also, less fugitive emissions may help lower the risk of fires.

References

Personal communications with BWIP, Crane, and Dean pumps by Harold Lips, BAAQMD, 1990.

EPA-450/3-88-010, Report on Fugitive Emissions (SOCMI report), October 1988.

Personal communications with the refineries by Wayne Kino, BAAQMD, September, 1990.

CM# C3: IMPROVED VALVES AND FLANGES AT REFINERIES AND CHEMICAL PLANTS RULE

Background

This control measure would reduce RHC emissions from valves and flanges at chemical plants and refineries by requiring improved packing materials and gaskets, and a more stringent inspection and maintenance program.

Valves are used for regulating the flow of a fluid in a piping system by permitting or blocking the passage of gases or liquids. Valves in hydrocarbon service can have fugitive emissions of organic compounds due to leaking valve-stem packing materials.

Flanges are the projecting rims of a pipe or piping component that are used to attach pipes or components together. Fugitive emissions from flanges can occur due to leaking gaskets.

Regulatory History

The District regulates the emissions of precursor organics from valves and flanges at petroleum refinery complexes under Regulation 8, Rule 18. The emissions from valves and flanges at chemical plants are regulated under Regulation 8, Rule 22. Rules 8-18 and 8-22 require that, if the concentration of organics at a distance of one-centimeter or less from the equipment is greater than 10,000 ppm, the leak must be repaired immediately, or minimized and repaired by the next turnaround if the equipment is considered essential.

Presently, Rules 8-18 and 8-22 require that accessible valves be inspected quarterly and inaccessible valves be inspected annually. There are also limits on how many valves can be awaiting repair. There are no periodic inspection requirements for flanges.

Emissions Subject to Control

The affected source category for refineries is *fugitives -- valves and flanges*. For chemical plants, the affected emissions are included within the category *fugitives (all mfg.) -- valves and flanges*. The projected emissions subject to control are given below. These estimates represent emissions from leaking equipment that would need to be replaced or modified.

Year	Emissions Subject to Control (TPD, Summer)
1994	2.51
1997	2.59
2000	2.66

Proposed Method of Control

Advances in technology have resulted in valves and flanges with reduced fugitive emissions. This control measure would require replacing older valves which leak with valves with "leakless" or other advanced designs. Valve and/or packing manufacturers seem willing to guarantee 500 ppm leak-levels, and data from the refineries show that 98 percent of existing

valves already meet this limit. In addition, EPA is proposing a leak-level of 500 ppm for valves and flanges at chemical plants, with no decision made yet on refineries. The South Coast AQMD now requires a leak-level of 1000 ppm. Requiring a leak-level of 100 ppm would result in a 70 to 95 percent reduction from the present estimated fugitive emission levels for valves and flanges.

This control measure also proposes more stringent inspection and maintenance procedures for valves and flanges. Some type of periodic inspection schedule for flanges could be added. In addition, leak checks should be required before installation.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 70 to 95 percent for affected sources.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	1.76	2.39
1997	1.81	2.46
2000	1.86	2.53

Costs of Controls

Assuming that components will comply by replacing packing material or gaskets, the cost would be about $300 per leaking valve and $50 per leaking flange. These cost estimates are from vendors for adding new carbon base packing. Since 98 percent of the valves already achieve 500 ppm and most of the leaking valves will probably be control valves, it is estimated that about 10 percent of the valves will require new packing material. As an approximation, it can also be estimated that 10 percent of the flanges will need new gaskets.

The labor costs for these changes will be minimal because mainly control valves will need to be modified (these valves need to be maintained on a periodic basis). There will be no additional operation and maintenance costs. For flanges, approximately one-hour of labor is estimated. Some unidentified cost savings will result from this control measure due to less product losses.

The overall cost-effectiveness of this control measure is estimated to be about $1000 per ton of RHC reduced.

Other Impacts

This control measures will reduce emissions of benzene, a toxic air contaminant, as well as lower the amount of odorous emissions. There will also be less product loss resulting in more efficient refinery and chemical plant operation. Also, less fugitive emissions may help lower the risk of fires.

References

Personal communications with Garlock and Chesterton by Harold Lips, BAAQMD, 1990.

EPA-450/3-88-010, Report on Fugitive Emissions (SOCMI report), October 1988.

DCN 79-219-370-03, Radian Report on Valve Leak Rates, January 24, 1979.

CM# C4: IMPROVED PROCESS VESSEL DEPRESSURIZATION RULE

Background

This control measure would reduce RHC emissions from process vessel depressurization at petroleum refineries and chemical plants by improving depressurization standards and by establishing flare gas recovery system sizing requirements.

The evacuation of process units during shutdowns and turnarounds is potentially a significant source of RHC emissions. Typically, a process unit is shut down by depressurization into a fuel gas or vapor recovery system with further depressurization to nearly atmospheric pressure by venting to a flare system. Although emissions are substantially reduced in this manner, some residual organic compounds are emitted from the depressurized vessels and excess emissions also can occur from inadequately sized flare systems.

Regulatory History

The District regulates the emissions of precursor organics from process vessel depressurization at petroleum refineries and chemical plants under Regulation 8, Rule 10. This Rule was last modified in 1983. Rule 8-10 requires that pressure vessels be vented to a flare or control device until the vessel's pressure is less than 5 psig. There are no efficiency requirements on the flare or other control devices used during depressurization of the vessel.

Emissions Subject to Control

The affected source category is *fugitives -- vessel depressurization*. A portion of the emissions included in the category *flares and blowdown systems* are also assumed to be affected. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	.13
1997	.14
2000	.14

Proposed Method of Control

This control measure proposes more stringent depressurization standards. A vapor recovery system, such as a regenerative carbon adsorption system, could be used for controlling RHC emissions from depressurized pressure vessels (depressurized to 5 psig, or less). There are also other control techniques that could be used effectively. The same types of controls that are used for degassing storage tanks could be used, including refrigeration, incineration, or certain types of scrubbing. A 95 percent control efficiency should be achievable.

For the flare system, the compressor for the flare gas recovery system should be sized to be able to handle 200 percent of the normal flow to the flare. This is so that the flare can

adequately handle the additional flow from the depressurizing of vessels. Also, the compressor should not be at its maximum flow operation for more than two percent of the time. By sending less gas to the flare, there will be a reduction in RHC (and CO and NOx) emissions. The increased flare gas recovery system would also help to lower flare emissions during other upsets. More research needs to be done to estimate emission reductions from an improved flare gas recovery system. At a minimum, 20 to 50 percent reductions should be achievable.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Fugitive RHC emissions were assumed to be reduced by 90 to 95 percent for vessel depressurization. The RHC emissions from flaring associated with vessel depressurization were assumed to be reduced by 20 to 50 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.03	.07
1997	.03	.07
2000	.03	.07

Costs of Controls

For depressurizing pressure vessels, a portable regenerative system which will allow for recovery of the vented organics should be feasible. This type of control should be affordable because the system can also be used when storage tanks are degassed. Using the EPA's OAQPS manual (page 4-40) and taking no credit for the recovered organics, the annualized costs of a typical-size system is estimated to be $140,000. These costs are for a fixed system which treats a continuous effluent stream and removes 432 tons of organics annually. Assuming that the portable system used for vessel depressurization would only be used 6 months per year, and would cost 50 percent more than a continuous system, the cost would be $210,000 per year to remove 216 tons of organic per year. This results in a cost-effectiveness of about 1000 per ton of RHC reduced.

Cost estimates for improved flare gas recovery systems are not known at this time.

Other Impacts

These control measures will reduce emissions of benzene, a toxic air contaminant, as well as lower the amount of odorous emissions. There will also be less product loss resulting in more efficient plant operations.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may

negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_X and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

References

OAQPS Control Cost Manual, EPA, Jan 90, PB90-16995.

Literature form Baron-Blakeslee and Westates Carbon, Inc.

CM# C5: IMPROVED WASTEWATER (OIL-WATER) SEPARATORS RULE

Background

This control measure would reduce RHC emissions from certain non-municipal wastewater treatment sources including oil-water separators, dissolved air floatation (DAF) units, and drains and junction boxes, by requiring covers on small units and by requiring specified units to be vented to abatement devices. This measure would primarily affect refineries, and possibly some oil production fields and other facilities.

RHC emissions from wastewater treatment plants include fugitive VOCs and dissolved organic gases that evaporate from the surfaces of wastewater contained in open drains and wastewater separators. Treatment processes such as DAF units, which involve extensive contact of wastewater and air, also can have significant fugitive RHC emissions.

This measure addresses the control of emissions which occur at the initial wastewater treatment operations. Control Measure #27 includes proposed controls for secondary treatment units.

Regulatory History

The District regulates the emissions of precursor organics from wastewater (oil-water) separators under Regulation 8, Rule 8. This Rule was last modified on November 1, 1989. Presently, Rule 8-8 requires that oil-water separators, DAF units, and junction boxes be covered, but the vents do not need to be controlled. Most of these requirements become effective August 4, 1991. Small wastewater separator systems with capacities under 200 gallons per day are not subject to these requirements.

The South Coast AQMD, in their 1989 AQMP revision, has proposed to remove the small-unit exemption from their wastewater separator rule (CM #88-B-3).

Emissions Subject to Control

The affected source category is *wastewater -- (oil-water) separators*. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	2.58
1997	2.66
2000	2.73

Proposed Method of Control

One proposed control is to remove or lower the existing 200 gallon per day exemption, and require even small units to be covered. The solid covers that would be required are well known and widely used in the petrochemical industry.

Another proposed control is to require that the vents from specified covered units be controlled. This could be accomplished by venting the units to an existing combustion device such as a process heater. Alternatively, a separate control system such as an incinerator or carbon adsorber could be installed. These type of controls would be expected to result in RHC reductions of about 95 percent from affected sources.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. Fugitive RHC emissions were assumed to be reduced by 90 to 95 percent from affected sources.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	2.32	2.45
1997	2.39	2.53
2000	2.46	2.60

Costs of Controls

It is estimated that a small wastewater separator system could be covered for less than $1000. The costs for installing add-on controls to a refinery wastewater system have been estimated based on information available from EPA. The following costs assume units are already covered and that a new control device must be added (i.e. an existing system such as a process heater is not used). The costs listed below are for a two million gallon per day system. The typical refinery would require two of these systems.

Units	Capital Cost	Operating Cost
Drains & Junction boxes	$159,000	$60,000/year
Oil-water Separator	$100,000	$46,000/year
DAF unit	$100,000	$46,000/year

The system for drains and junction boxes is high because of the piping required. It would be possible to combine the three controls systems and lower the total costs.

The overall cost-effectiveness of this control measure is estimated to be about $3000 per ton of RHC reduced.

Other Impacts

This control measure will reduce emissions of benzene, a toxic air contaminant, as well as lower the amount of odorous emissions. If the recovered product is recycled, these systems will reduce product losses.

Where RHC emissions are controlled by incineration, emissions of CO and NOx may result. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of fuels in the thermal oxidation abatement devices.

References

VOC Emissions from Petroleum Refinery Wastewater Systems Background Information for Proposed Standards, EPA, PB87-190336, Feb. 85.

CM# C6: FURTHER CONTROL OF EMISSIONS FROM WASTEWATER TREATMENT AT REFINERIES

Background

This control measure would reduce RHC emissions from secondary wastewater treatment processes at refineries by requiring covers on wastewater processing equipment, by replacing wastewater ponds with covered tanks (or by controlling wastewater streams), and by requiring control of pond desludging operations.

RHC emissions from wastewater treatment plants include fugitive VOCs and dissolved organic gases that evaporate from the surfaces of wastewater contained in open drains, wastewater separators and ponds. Treatment processes such as aeration ponds and dissolved air flotation (DAF) units, which involve extensive contact of wastewater and air, also can have significant fugitive RHC emissions. Pond desludging is a periodic activity that results in evaporative hydrocarbon emissions.

This measure addresses the control of wastewater treatment plant emissions which occur downstream of the DAF units. Control Measure #37 includes proposed controls for the initial treatment steps which include the drains and junction boxes, oil-water separators, and the DAFs.

Regulatory History

The District regulates the emissions of precursor organics from wastewater separators, forebays, and air flotation units at petroleum refinery complexes under Regulation 8, Rule 8. This Rule was last modified on November 1, 1989. Presently, Rule 8-8 requires that oil-water separators, DAF units, and junction boxes be covered, but does not require that the vents be controlled. The rest of the wastewater treatment process is currently not covered by District regulations.

In addition, Regulation 11, Rule 12 adopts by reference 40 CFR Part 61, Subpart FF -- National Emissions Standards for Benzene Emissions from Benzene Waste Operations. The standards in this Rule, adopted on July 18, 1990, also affects refinery wastewater operations.

Emissions Subject to Control

The affected source category is *refinery wastewater treatment facilities*. Some emissions included in the category *refinery wastewater separators* are also assumed to be affected. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	1.85
1997	1.91
2000	1.96

Proposed Method of Control

The controls proposed for wastewater treatment plants include the covering of wastewater processing and holding tanks. Emission reductions from these sources can be maximized by using floating roof tanks where feasible, or by venting covered or enclosed tanks to a suitable abatement device. It is assumed that most wastewater ponds will need to be replaced by large holding tanks. Controlling the wastewater stream may be allowed as an alternative to pond replacement. Fugitive VOCs from wastewater can be reduced by stripping and abating the wastewater stream before extensive contact with the atmosphere occurs. It is estimated that application of the controls proposed will result in fugitive VOC emission reductions from affected sources of 90 to 95 percent.

Controlling pond desludging will most likely involve treatment of sludge by incineration, although other technologies may be acceptable. This type of control has been previously specified as a BACT-level control in new/modified permits.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 90 to 95 percent from affected sources.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	1.67	1.76
1997	1.72	1.81
2000	1.77	1.87

Costs of Controls

The most significant costs are likely to be for installing the large tanks to replace the ponds. Assuming that the typical refinery has a wastewater flow of 4 million gallons per day and needs three days of residence time for treatment, three 4-million gallon tanks will be required (these tanks will need some type of air spurgers). The installed costs of these three tanks, including piping and vent controls is estimated to be about $6,000,000.

The annual operating costs should be similar to existing costs; no additional operating costs are expected except for vent controls. The annual operating costs of vent controls are estimated to average roughly $45,000 per system.

The costs for closing the ponds, and treating the sludge were not available. Desludging the ponds and leaving them open for emergency use may be acceptable.

The overall cost-effectiveness of this control measure was estimated to be about $10,000 per ton of RHC reduced.

Other Impacts

This control measure will reduce emissions of benzene, a toxic air contaminant, as well as lower the amount of odorous emissions.

Where RHC emissions are controlled by incineration, emissions of CO and NOx may result. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of fuels in the thermal oxidation abatement devices.

References

I.V. Klumpar, S.T. Slavsky "Updated Cost Factors: Process Equipment", Chemical Engineering, page 73, July 22, 1985.

VOC Emissions from Petroleum Refinery Wastewater Systems Background Information for Proposed Standards, EPA, PB87-190336, Feb 85.

CM# C7: CONTROL OF EMISSIONS FROM PETROLEUM REFINERY FLARES

Background

This control measure would reduce RHC and NOx emissions from petroleum refinery flares. The measure would eliminate all routine flaring activity and would permit the operation of a flare solely as an emergency device. Emissions will be reduced largely by improved flare gas recovery systems. The control measure is also directed at improving the efficiency of combustion of waste gases, and improving flare monitoring.

Because the exhaust gases of existing flares are difficult to monitor, the flare has become one of the few sources at petroleum refineries that is not subject to regulations regarding minimization of usage, control device efficiency, or even monitoring. Data collected during intensive investigation of flare episodes has indicated that flare emissions can be substantially greater than emissions estimated using average emission factors, which are based on good operating combustion efficiency.

Regulatory History

The District currently does not have a specific rule directed at reducing the RHC emissions from petroleum refinery flares. There are no existing District limitations regarding the combustion efficiency of flares for organic compounds (or for any other pollutants).

Flares must comply with District Regulation 6 regarding plume opacity; although under actual operating conditions and sometimes during maximum releases from flares, exemptions from the opacity standards are granted for refinery upset or breakdown of equipment.

The South Coast AQMD has adopted a control measure in their 1989 AQMP revision directed at petroleum refinery flares (CM #88-B-12).

Emissions Subject to Control

The source category affected is *refinery flare and blowdown systems*. The projected RHC and NOx emissions subject to control are given below. These emission estimates are based on average emission factors, which may substantially underestimate actual emissions. It should be noted that there may be some overlap between this control measure and CM# C4, which is directed at reducing emissions from process vessel depressurization.

Year	Emissions Subject to Control RHC (TPD, Summer)	Emissions Subject to Control NOx (TPD, Summer)
1994	.27	.22
1997	.27	.23
2000	.28	.23

Proposed Method of Control

The main method of control would be to recover over 90 percent of the organic compounds which are currently diverted to flares, through the use of more effective flare gas recovery systems. In addition, elimination of conditions leading to upsets and breakdowns and improved design of equipment and operations should reduce the flow of gases to flares.

Improved design considerations, such as regulation of turndown, will also reduce emissions (e.g. cascading flare system -- water seals blown at inlets of the flare as throughput demand increases).

The majority of flaring activity could also be controlled by enclosed fireboxes, which would greatly improve combustion parameters. Finally, greatly improved monitoring, both upstream and downstream of the fireboxes, will result in more efficient operation.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. RHC emissions were assumed to be reduced by 70 to 80 percent from affected sources. NOx emissions were assumed to be reduced by 30 to 40 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

	RHC Reductions (Summer)		NOx Reductions (Summer)	
Year	Emiss. Reduced Low (TPD)	Emiss. Reduced High (TPD)	Emiss. Reduced Low (TPD)	Emiss. Reduced High (TPD)
1994	.19	.21	.07	.09
1997	.19	.22	.07	.09
2000	.20	.22	.07	.09

Costs of Control

A rough estimate of the costs of this control measure is $5 million per refinery, although no detailed cost estimates have been made. The cost-effectiveness of this control measure has not been quantified at this time.

Other Impacts

The control measure will result in fewer visible flames from flaring, as well as reduced emissions of CO and particulate matter. There may also be significant reductions in the emissions of odorous substances.

References

None.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

D. COMBUSTION OF FUELS

CM# D1: CONTROL OF EMISSIONS FROM NON-UTILITY RECIPROCATING ENGINES

Background

This control measure would reduce NOx emissions from stationary reciprocating internal combustion (IC) engines by establishing NOx standards for these sources. In nearly all instances, the measure would require the installation of add-on controls to existing unregulated engines to meet mandated NOx levels, or the replacement of IC engines with electric motors. It is anticipated that the measure would affect engines with 50 HP output or greater.

The District currently permits about 180 non-electric generating reciprocating IC engines. Many more are operating, because engines with less than 250 HP are exempted from permitting requirements. These facilities do not have add-on controls, such as nonselective catalytic reduction (NSCR) and selective catalytic reduction (SCR), applied to their engines and would therefore be affected by this control measure. Some do have combustion modifications which are directed at increasing engine efficiency and/or reducing NO_X emissions.

EPA's "Compilation of Emission Factors" (AP 42) gives emission factors for uncontrolled IC engines, depending on size, function and fuel type. These emission factors are summarized below:

AP 42 Uncontrolled NOx Emission Factors in Gm/HP-Hr

	Natural Gas	Gasoline	Dual Fuel	Diesel
Heavy Duty Natural Gas Fired Pipeline Compressor Engines	13			
Industrial Engines		5		14
Large Bore Diesel & Dual Fuel Engines			8	11

Many factors affect the actual emissions of IC engines once they are in operation, such as air-fuel ratio, ignition timing and combustion temperature. These can be highly variable. Regular maintenance and tuning are critical to controlling emissions from these engines with or without engine modifications or add-on control devices.

Regulatory History

Currently, the District does not specifically regulate emissions from existing reciprocating engines. IC engines with less than 250 HP output rating are exempt from permitting requirements.

On October 26, 1979, the State of California Air Resources Board (CARB) staff released a "Proposed Strategy for the Control of Oxides of Nitrogen From Stationary Internal

Combustion Engines". The report asserted "technology is available to reduce NO_x emissions to no more than 0.28 ug/joule (0.75 gm/brake hp-hr)." CARB staff proposed that all new engines meet this limit by January 1, 1982, and that all existing engines except diesels meet the limit by January 1, 1983. It was proposed that existing diesels meet a limit of 3.0 ug/J (8.1 gm/brake hp-hr) by January 1, 1981.

The CARB staff proposal for IC engines was not formally recommended to the Bay Area for adoption. However, it is a useful indication of the state-of-the-art of NO_x control a decade ago. Progress in emission control strategies for reciprocating engines can be tracked to some extent by noting changes in rules developed by the South Coast AQMD (SCAQMD).

SCAQMD Rule 1110.1 (adopted 10/26/84) regulated emissions from stationary IC engines. It set requirements for engines with more than 50 rated brake horsepower as follows: (1) rich-burn engines -- 90 percent reduction in NO_x emissions initially and 80 percent thereafter, or a NO_x limit not to exceed 90 ppm (by volume, dry) at 15% O_2, and a CO limit not to exceed 2000 ppm (by volume, dry) at 15% O_2; (2a) lean-burn engines -- 80 percent reduction in NO_x emissions initially and 70 percent thereafter, or a NO_x limit not to exceed 150 ppm (by volume, dry) at 15% O_2 (no CO limit), or (2b) engines controlled exclusively by combustion modification -- NO_x not to exceed 2 g/bhp-hr or 150 ppm (vol., dry) at 15% O_2. A few engines were exempted from this rule.

Kern County Rule 427 currently has NO_x and CO limits identical to those in SCAQMD Rule 1110.1.

Ventura County Rule 74.9 (adopted 7/21/85, revised 7/2/85, 9/5/89) closely parallels South Coast Rule 1110.1. The NO_x limit for rich-burn engines is 50 ppm @ 15% O_2, or no less than 90 percent reduction; for lean-burn engines the limit is 125 ppm @ 15% O_2, or no less than 80 percent reduction. The CO limit is 4500 ppm @ 15% O_2. The RHC limit is 250 ppm (15% O_2) for rich-burn, and 750 ppm (15% O_2) for lean-burn.

The above rules allow for a great variation in the level of actual emissions, since the limit is expressed as a permissible concentration <u>or</u> the percent reduction (across a control device or relative to a baseline emission rate). It is unclear how a percent reduction can be determined if the control measure employed is engine modification. These rules typically do not clearly state baseline conditions or cite AP 42 emission factors as a reference. There are also uncertainties if the limit is taken as a percent reduction across a control device. Without requiring that the engine itself be tuned to both optimize efficiency and minimize emissions, "controlled" emissions could be high. For all these reasons, this sort of limit is difficult to enforce. An emission limit expressed as a concentration or based on engine output is a more practical solution.

On 8/3/90, the South Coast AQMD adopted Rule 1110.2, Emissions from Gaseous- and Liquid-Fueled Internal Combustion Engines. This Rule supersedes 1110.1 and is vastly more stringent. It requires that all stationary IC engines over 50 bhp, and all portable engines over 100 bhp, be replaced with an electric motor, or reduce emissions of CO to 2000 ppm, of NO_x to 36 ppm (approx. 0.44 to 0.49 gm/brake hp-hr) and of RHC measured as methane to 250 ppm (all measured by volume corrected to 15 percent oxygen on a dry basis and averaged over 15 minutes). This emission limit corresponds to a 93 to 97 percent reduction from the AP 42 emission factors. The requirements are modified by an efficiency factor for electric power generating engines, landfill-gas- or sewage-digester-gas-fueled engines and others. There are exemptions for certain engines such as those used in agriculture, for emergencies, for research, etc.

Emissions Subject to Control

The affected source categories are *reciprocating engines* for gasoline, gas, and other liquid fuels, as well as *cogeneration -- reciprocating engines*. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	9.01
1997	9.45
2000	9.86

Proposed Method of Control

The NOx limit specified in SCAQMD Rule 1110.2, 36 ppm @ 15% O_2 dry, is proposed for the Bay Area. This control measure will typically require the installation of add-on controls to previously unregulated, and some unpermitted, equipment. Compliance is also possible by replacement with electric motors.

There are three broad categories of control measures for emissions from IC engines: operational modifications, engine combustion modifications, and post-combustion flue gas treatment (add-on controls). Often, NO_x control can greatly increase CO and RHC emissions. Therefore the rule developed will also specify CO and/or RHC limits. Electrification will have the added advantage of reducing CO and RHC emissions.

Operational Modifications

Operational modifications to reciprocating IC engines include changes in the air-fuel ratio, engine derating and spark or fuel ignition timing retard.

The air-fuel ratio is defined as the mass flow rate of air divided by the mass flow rate of the fuel. Operating an engine leaner than stochiometric generally increases NOx emissions, but decreases CO and HC emissions. Operating an engine rich will reduce NOx, but can also increase CO and HC. Adjustment of the air-fuel ratio can achieve NO_x reductions of between 14 percent (diesel and dual fuel engines) and 44 percent (gaseous fuel engines).

An engine is derated by limiting its power output. The cylinder pressure and temperature are thus lowered, reducing the NO_x formation rates. A 25 percent derate can give average NO_x reduction of 34 percent with an average increase in fuel consumption of 6.5 percent. This method also increases RHC and CO emissions.

Peak cylinder temperatures may be reduced by retarding the spark timing, in gaseous fueled engines, and fuel injection timing, in diesel or dual-fuel engines. The NO_x emissions are diminished because of the reduced time spent at elevated temperature. A retard of 6 degrees gives an average 25 percent reduction in NO_x. There is generally no effect on RHC or CO emissions.

None of these methods is sufficient to meet the stringent emission requirement of 36 ppm @ 15% O_2. However, post combustion controls are often added to engines employing operational modifications. These post combustion controls must also be designed to any added RHC and CO emissions.

Engine Combustion Modifications

Engine modifications include stratified combustion (in which a fuel rich layer is situated near the spark plug), lean combustion (high air/fuel ratio), exhaust gas recirculation, and water injection. These methods usually involve various means to reduce combustion temperature and thus reduce thermal NO_x formation. The technologies available depend on the type of engine and the type of fuel.

Pre-Stratified Charge (PSC) NO_x control has been applied to rich-burn engines, achieving NO_x emissions of 1.7 to 3 g/bhp-hr (100 to 200 ppm). These emissions are 40 to 80 percent below the AP 42 emission factors shown above; however, they are significantly short of the potential NO_x reductions achievable with add-on control technology. This control method is highly dependent on engine tuning; it also increases CO and HC emissions, and may reduce the maximum horsepower output.

Recently there has been a great improvement in engine combustion modification for NO_x control for both two- and four-stroke, spark-ignited engines. Five years ago NO_x specific emissions of 1.5 g/bhp-hr (100 ppm) were achieved for engines retrofitted by combustion modification, but today NO_x specific emissions of 0.29 to 0.59 g/bhp-hr (24 to 38 ppm) have been reported in initial tests for five 2000 bhp two-stage combustion retrofitted engines in the SCAQMD.

Post-combustion Flue Gas Treatment

Post-combustion flue gas treatment is generally more effective in controlling NO_x emissions than combustion modification. The most effective add-on control technologies are selective catalytic reduction (SCR) and nonselective catalytic reduction (NSCR). These technologies reduce NO_x formed during combustion, to N_2 and water or CO_2, through the use of a reducing agent and a catalyst. SCR and NSCR have been proven in practice and are commercially available.

SCR technology can be applied to lean burn engines (high air/fuel ratio). It uses ammonia added to the flue gas as a reducing agent. The gas then passes through a catalyst grid system. The NO_x emissions are reduced by the ammonia to N_2 and water vapor over the catalyst surface. SCR achieves the best results at temperatures between 200^o C and 400^o C. For SCR technology, previously uncontrolled lean-burn engines have achieved reductions in NO_x emissions to within the South Coast limit of 36 ppm.

The NSCR process uses fuel-rich engine operation to provide reducing agents in the flue gas. The gas then passes over a catalyst where NO_x is reduced to nitrogen and water or CO_2. For rich-burn engines with NSCR control technology, NO_x emissions of 36 ppm have been achieved in practice.

A new development for diesel engine NO_x control is the Raprenox Process, in which the exhaust NO_x is treated in a reaction chamber with a reducing agent, cyanuric acid, to form N_2 and CO_2. In this process, a catalyst is not required to complete the chemical reaction for NO_x reduction. A NO_x reduction of 95 percent has been claimed on a 50 kw diesel engine. Work is continuing on a 100 kw diesel engine. A large scale test has been completed on a one megawatt (1340 bhp) diesel in Irvine, California, with a claimed NO_x reduction of 98 percent. A Raprenox system is also being added to a 6 MW facility in Hawaii. The vendor has stated that this process can potentially improve engine efficiency, since the engine can be run at higher NO_x levels. The Raprenox process is, however, dependent on exhaust temperatures and, therefore, may not be well suited for all engines.

SCR and NSCR control technologies are becoming commonly used by various source categories throughout urban areas in California. This is largely due to federal and local PSD and BACT requirements. The concentration limits in South Coast Rule 1110.2 are achieved in practice by natural gas and gasoline-fueled reciprocating IC engines. Although electrification is expensive (up to $20,000 per ton reduced), some facilities may choose this control option.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the NOx emissions from affected sources would be reduced by 70 to 90 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	6.31	8.11
1997	6.61	8.49
2000	6.90	8.87

Costs of Control

Add-on controls will be required in order for natural gas and gasoline-fired IC engines to meet the proposed NOx limit. Highly effective post combustion controls will probably be demonstrated and available for diesel engines within five years. Data from SCAQMD puts the annual cost for NSCR at $50 per horsepower and for SCR at $100 per horsepower. A control technology supplier states that NSCR costs about $100 per horsepower for 50-250 HP engines, $66 per horsepower for 250-1200 HP engines and somewhat less for larger engines. This supplier also estimates the cost of SCR at $100 per horsepower. At this time, cost figures for the Raprenox process are not available.

Cost-effectiveness estimates vary greatly depending on the actual load and hours of operation of the engine. Cost-effectiveness estimates have been calculated based on operations ranging from between 1000 to 8000 hours per year (depending on engine type and typical operations) and emission reductions of 93 percent to 97 percent from AP 42 emission factors. These costs are based on BAAQMD and SCAQMD calculations and supplier estimates.

Cost Summary

Control Option	Total Annual $ Cost/bhp	Cost-Effectiveness $/Ton
SCR	100	2,600 - 16,000
NSCR	50-100	1,000 - 9,000
Electrification		23,000

Other Impacts

NOx reductions in general, including those associated with the proposed control measure, can cause localized increases in ozone concentrations.

The electrification option would create additional demand for electricity. Any additional electricity generated within the District would generate the pollutants associated with the type of electrical generating facility used. However, it is expected that there would be a net reduction in NOx emissions from current levels. CARB has estimated that a 100 horsepower reciprocating engine would emit 2.6 pounds of NO_x per hour while an electric motor of 100 horsepower would cause the emission of 0.46 pounds of NO_x per hour, at an uncontrolled power plant burning oil (CM# D3 proposes significant NOx controls for electric power generating boilers). By comparison, a 100 horsepower IC engine meeting the proposed emission limits would emit 0.11 pounds of NOx per hour. With the electrification option, there will also be reductions in particulates, RHC, and CO emissions.

SCR and NSCR control technologies may create impacts from ammonia emissions. Ammonia is a toxic compound and its production, use, storage, and transport can be hazardous. Worker or public health could be impacted in the event of an accidental release or spill. Low level operating emissions from "ammonia slip" are possible, but would probably be insignificant. Some increase in truck traffic, and the associated vehicle emissions can be expected due to the delivery of raw ammonia.

The proposed control measure could adversely affect local water resources as a result of SCR and NSCR control technologies. For engines using fuels with a high sulfur content and having a high ammonia slip, the use of SCR for NO_x removal may cause ammonium bisulfate and/or ammonium sulfate deposits to form downstream from the unit reactor, producing plugging and corrosion. These deposits are usually removed from the SCR system using water or steam soot blowing techniques. Catalyst regeneration through washing would create wastewater requiring proper handling and treatment to avoid contamination of water resources. The accidental release of ammonia could also adversely affect water quality.

Two types of solid waste would result from the proposed control measure: (1) The electrification option would result in the disposal of obsolete IC engines if they are not recycled and, (2) SCR catalysts have a lifespan of 2 to 7 years, depending on the type of fuel used, impurities in the fuel, and the NO_x emission reduction efficiency required. If the spent catalyst is disposed of, several cubic yards of solid materials which may be considered hazardous, would require proper handling and disposal.

Impacts to soils could occur from removal of IC engines and their fuel supply systems. Fuel and lubricating oils may leak or spill during engine removal and result in soil contamination.

References

CARB Proposed Strategy for the Control of Oxides of Nitrogen Emissions from Stationary Internal Combustion Engines, October 26, 1979.

SCAQMD Staff Report for Proposed Rule 1110.2 - Emissions From Gaseous- and Liquid-fueled Internal Combustion Engines, July 11, 1990.

SCAQMD Rule 1110.1 Emissions From Stationary Internal Combustion Engines, (Adopted October 26, 1984, Amended October 4, 1985).

Ventura County APCD Rule 74.9 Stationary Internal Combustion Engines (Adopted 7/21/81, Revised 7/2/85, 9/5/89).

SCAQMD Rule 1110.2 Emissions From Gaseous- and Liquid-Fueled Internal Combustion Engines.

Houston Industrial Silencing, Letters to BAAQMD, dated January 16, 1991.

CM# D2: CONTROL OF EMISSIONS FROM STATIONARY GAS TURBINES

Background

This control measure would reduce NOx emissions from stationary gas turbines by establishing stringent NOx standards for these sources. In most instances, the measure would require the installation of a selective catalytic reduction (SCR) system to meet the proposed NO_x limits. It is anticipated that the control measure would affect gas turbines with an output of one-megawatt (MW) or greater.

Currently, about 10 to 20 such gas turbines are operating within the District. Most of these turbines have NO_x controlled via steam or water injection, to 25 or 42 ppm @ 15 0_2, averaged over any 3-hour period. This control measure would reduce NO_x emission to specified levels, depending on turbine size. NO_x would be reduced by steam or water injection and/or SCR, depending on the quantity of NO_x to be reduced. Some peak-load turbines may reduce NOx emissions by methanol-fueling.

Regulatory History

Currently, the District does not specifically regulate NOx emissions from existing gas turbines, although all stationary gas turbines need permits, except if they meet the requirements of Regulation 2-1-110.2 which excludes "any engine used solely as a standby source of motive power".

Most existing turbines are subject to the NSPS requirements found in CFR, Part 60, Chapter 1, Title 40, Subpart GG entitled "Standards of Performance for Stationary Gas Turbines", passed on 9/10/79 and amended on 2/14/89. These standards are included in the District's regulations by reference. The NOx limits established in this NSPS can be easily met with water or steam injection.

Currently, the most stringent District requirements for gas turbines are for new/modified units that are subject to the District's NSR Rule. Projects with NOx emissions which exceed 150 lb/day or 25 TPY (cumulative increase) must meet stringent BACT requirements.

The South Coast AQMD currently regulates the emissions from existing gas turbines under SCAQMD Rule 1134, which was adopted on August 4, 1989. The SCAQMD Rule establishes NOx limits which range from 9 to 25 ppm (measured by volume corrected to 15 percent oxygen on a dry basis and averaged over 15 minutes). The requirements are modified by an efficiency factor.

Emissions Subject to Control

The affected source categories are *turbines* for gas and liquid fuels, *cogeneration -- turbines*, and *power plants -- turbines*. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	10.3
1997	10.8
2000	11.3

Proposed Method of Control

NOx limits similar to those specified in SCAQMD Rule 1134 are proposed for the Bay Area. The proposed NOx limits are listed below.

Proposed NOx Limits for Gas Turbines

Unit Size Megawatt Rating	ppm (corrected to 15% O_2)
1 - 2.9 MW	25
2.9 - 9.9 MW	9
2.9 - 9.9 MW (no SCR)	15
10 MW and over	9
10 MW and over (no SCR)	12

Most turbines 10 MW and larger, will need an SCR system to meet the proposed NO_x limits. For cogeneration units, the SCR catalyst bed is generally placed in the economizer section of the HRSG, where the optimum temperature window occurs. Ammonia is injected into the gas just prior to entering the catalyst, where a reaction occurs transforming NO_x and NH_3 into N_2 and H_2. Ammonia, usually anhydrous, is stored on-site, near the turbine. Typical catalyst life is 2 to 7 years. Catalyst can periodically be "washed" to maintain needed removal efficiencies. It is expected that most installations that use SCR will also use water/steam injection to meet mandated NOx limits.

Small turbines, or those not equipped with SCR, will control NO_x emissions via steam or water injection, or by methanol-fueling. Both of these controls act to reduce flame temperatures, resulting in lower NO_x emissions. Methanol-fueling may be the most cost-effective control option for turbines which operate infrequently. These non-SCR measures have slightly less restrictive NOx limits, but may involve controls that are technology forcing.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the average NOx emission reductions from cogeneration turbines would be 60 percent. Other gas turbines were assumed to have NOx reductions of 60 to 80 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	6.17	6.57
1997	6.49	6.90
2000	6.77	7.18

Costs of Control

The costs of installing SCR are dependent on a number of factors including the size of the unit, the required abatement efficiency, and the hours of annual operation. Typical costs for a base-loaded, 25 MW turbine are roughly: $4,000,000 installed equipment costs and $500,000 annual operating costs. The cost-effectiveness in this example ranges from $2000 to $4000 per ton of NOx reduced, as indicated below.

NO_x emissions	% reduction	ppm	cost ($/ton)
3300 lb/day	0	120-150	0
1100	70	42	4000
660	80	25	3000
330	90	9	2000

The cost-effectiveness of SCR is dramatically reduced for turbines that operate only occasionally. For peak-load turbines which operate less than 1000 hours per year, methanol-fueling will most likely be the most cost-effective control option.

Water/steam injection is much cheaper than SCR, but the NOx reductions are not as great. A level of 25 ppm NO_x is all that can reasonably be expected from this control option in most cases. The costs of control using steam injection are essentially equal to the cost of generating the steam necessary to inject into the flame. For a 50 MW turbine, approximately 40,000 lb/hr steam are needed. The cost-effectiveness of water/steam injection is generally under $2000 per ton of NOx reduced.

The average cost-effectiveness of this control measure is estimated to be about $12,000 per ton of NOx reduced. Costs as high as $15,000 per ton reduced may occur for turbines that are difficult to retrofit and that will be used minimally.

Other Impacts

NOx reductions in general, including those associated with the proposed control measure, can cause localized increases in ozone concentrations.

The SCR process involves the use of ammonia. Ammonia is a toxic compound and its production, use, storage, and transport can be hazardous. Worker or public health could be impacted in the event of an accidental release or spill. Low level operating emissions from "ammonia slip" are possible (up to 10 ppm), but would probably be insignificant. Some increase in truck traffic, and the associated vehicle emissions can be expected due to the delivery of raw ammonia.

The proposed control measure could adversely affect local water resources as a result of regenerating SCR catalysts. For engines using fuels with a high sulfur content and having a

high ammonia slip, the use of SCR for NO_x removal may cause ammonium bisulfate and/or ammonium sulfate deposits to form downstream from the unit reactor, producing plugging and corrosion. These deposits are usually removed from the SCR system using water or steam soot blowing techniques. Catalyst regeneration through washing would create wastewater requiring proper handling and treatment to avoid contamination of water resources. The accidental release of ammonia could also adversely affect water quality.

The proposed control measure would result in solid waste impacts from disposed SCR catalysts. These catalysts typically have a lifespan of 2 to 7 years, depending on the type of fuel used, impurities in the fuel, and the NO_x emission reduction efficiency required. When the spent catalyst is disposed of, several cubic yards of solid materials which may be considered hazardous, would require proper handling and disposal.

Fairly substantial quantities of methanol may be needed for those turbines that use methanol-fueling to comply with the proposed control measure. Worker or public health could be impacted in the event of an accidental release or spill. Methanol's water solubility and lack of odor and taste could permit widespread pollution before a methanol spill is recognized. Methanol also burns with an invisible flame, making methanol flames dangerous and difficult to fight. A substantial increase in truck or rail traffic can be expected due to the delivery of methanol.

<u>References</u>

SCAQMD Rule 1134: Emissions of oxides of Nitrogen from Stationary Turbines.

"Application of SCR to Gas Turbine Cogeneration Systems with Variable - Load Supplemental Firing", B. Bateman, BAAQMD, 1985.

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CM# D3: CONTROL OF EMISSIONS FROM ELECTRIC POWER GENERATING BOILERS

Background

This control measure would reduce NO_X emissions from electric power generating boilers (or "utility" boilers) by establishing NOx standards for these sources. It is expected that, in most cases, the proposed NOx limits will be achieved by a combination of combustion modifications (e.g. staged combustion or low-NOx burners), and a post-combustion flue gas treatment method (e.g. selective catalytic reduction).

Utility boilers are generally defined as those units having a fuel heat input rate of 250 MMBTU/hour or higher. There are currently 21 such utility boilers within the District, all operated by Pacific Gas and Electric Company (PG&E). Most, if not all, of the PG&E boilers have some degree of NO_X controls installed to meet existing District regulations such as low excess air, overfire air ports, and/or flue gas recirculation.

Regulatory History

The EPA regulates new utility boilers under the New Source Performance Standards (NSPS), which apply to units for which construction commenced after 1971 (CFR Title 40, Chapter 1, Part 60, Subpart D) and after 1978 (Subpart Da). The NSPS limits NO_X emissions to 0.3 lb/MMBtu heat input for oil-firing and 0.2 lb/MMBtu for gas-firing. The NSPS standards have been adopted by the District by reference.

District Regulation 9, Rule 3, is as or more stringent than the NSPS, namely 225 ppm NO_X (about 0.3 lb/MMBtu) for oil-firing and 125 ppm NO_X (about 0.15 lb/MMBtu) for gas-firing. All utility boilers within the District must have operating permits and meet the requirements of Rule 9-3.

The South Coast AQMD is proposing an amended Rule 1135 which will require increasingly stringent controlled NO_X levels, on a sliding annual scale down to 0.20 lb NO_X/Net MW-hr (about 0.022 lb/MMBtu) for all their District utility boilers by December 31, 1999, plus a total pounds-of-NO_X-per-day cap for each utility company. The Ventura County APCD's proposed Rule 59 will limit NOx emissions to 0.10 to 0.20 lb NO_X/Net MW-hr (about 0.011 to 0.022 lb/MMBtu). Depending on a particular boiler's current "baseline" emission levels, NO_X reductions of approximately 75 to 95 percent will be required.

Emissions Subject To Control

The affected source categories are *power plants -- boilers* for gas and oil fuels. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	13.4
1997	15.0
2000	17.9

Proposed Method Of Control

Control technologies for NO_X emissions fall into two general categories: (1) combustion modifications which limit the actual formation of NO_X within the combustion chamber and, (2) flue gas treatment techniques which reduce NO_X after it is formed but before it reaches the stack. In general, combustion modification (CM) controls work by reducing excess combustion air, lowering the peak flame temperatures of combustion, and/or reducing the oxygen available at the peak flame temperatures. These combustion modifications include low excess air (LEA); staged combustion, e.g., through the use of overfire air ports (OFA); flue gas recirculation (FGR); and low-NO_X burners (LNB). Expected NO_X reduction capabilities of combustion modifications for oil and gas-fired boilers are listed below.

NO_X Controls for Utility Boilers

CM Technique	% Reduction
LEA	5-25
OFA	25-35
FGR	40-50
LNB	30-50
Flue Gas Treatment	
AI/UI	35-50
SCR	80-90

The actual NO_X reductions achieved will be boiler-specific and be dependent on the fuel and fuel properties (e.g. the nitrogen content of the fuel oil). Furthermore, while these techniques are often sequentially applied in the order listed in the table above to achieve ever lower NO_X emissions, the actual NO_X emission reduction percentages are not additive.

Post-combustion flue gas treatment destroys the NO_X after it is formed; these technologies include (1) selective non-catalytic reduction (SNCR), e.g. ammonia or urea (an ammonia-based chemical compound) injection and, (2) selective catalytic reduction (SCR). Both technologies lower NO_X emissions by using a reducing agent, ammonia or urea, to reduce the NO_X molecules to nitrogen and water. While combustion modification techniques are generally confined to relatively small hardware changes within the combustion furnace, the post-combustion flue gas treatment techniques, particularly SCR, require major hardware installations at the power boiler. So while ammonia/urea injection and SCR can achieve up to 50 percent and 90 percent NO_X reduction, respectively, their complexities and operating costs are significantly higher than those of CM techniques.

The SNCR process selectively reduces NO_X with injection of ammonia or urea into the flue gas at temperatures ranging from 1600^oF to 1800^oF without a catalyst. The SNCR method, while reducing NO_X up to 50 percent, is very temperature sensitive and is limited to the temperature window indicated. Typically, the reducing agent is injected into the economizer section of the boiler. However, boiler-specific retrofit installation restraints may be encountered.

The SCR process uses a catalyst to lower the required temperature of NO_X reduction to less than 800^oF, achieving up to 90 percent NO_X reduction. The SCR reactor is typically installed downstream of the boiler economizer and upstream from the air preheater.

The utility boilers operated within the District by PG&E generally have low excess air, overfire air and flue gas recirculation controls installed (mostly if not all retrofits) to meet existing District regulations. The next level of control would logically be the installation of low NO_X burners. While no significant problems have been reported for gas-firing, there is concern about increased particulate emissions with oil-fired low NO_X burners (these burners generally have dual-fuel capability). However, considering that any new NO_X control measure will probably be gradually phased in, the latter should not be a problem for PG&E because it expects to phase out use of fuel oil and convert to all natural gas in their conventional fuel utility boilers by 1993.

The flue gas treatment techniques have on-going full-scale demonstrations in California, e.g., a urea injection system in a San Diego Gas & Electric Company oil- and gas-fired utility boiler and an SCR installation at a Southern California Edison unit. Although these flue gas NOx controls have not been extensively demonstrated on utility boilers in the United States, the technologies are being used successfully on dozens of units in Japan and Europe.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the average NOx emission reductions from this control measure would be 80 to 90 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	10.8	12.1
1997	12.0	13.5
2000	14.3	16.1

Costs of Control

The South Coast AQMD has estimated the following NO_X control capital equipment costs:

NO_X Technique	$/kW Installed
OFA	1-2
FGR	10
LNB	30
AI/UI	10
SCR	30

Obviously, annual operating and maintenance costs need to be added on. The SCAQMD estimates the cost-effectiveness of combining combustion modification controls with SCR to be approximately $4000 per ton of NOx reduced (1990 dollars). It should be noted that the figure is based on costs submitted by one vendor (Mitsubishi) and perhaps specified on one model boiler.

A more recent, detailed analysis by the Ventura County APCD indicates a cost-effectiveness range of $9000 to $18,000 per ton of NOx reduced (adjusted to 1990 dollars). PG&E has made a preliminary estimate that it would take approximately $500,000,000 to install SCR on all their District boilers. Using this figure and assuming an annual operating and maintenance factor of 5 percent, the cost-effectiveness of an 80 to 90 percent NOx reduction is about $16,000 per ton reduced (based on a capital recovery factor of 12.5 percent).

It should be noted that retrofit control costs are quite boiler specific and can range up to 100 percent higher than original engineering estimates. Furthermore, because a because a significant fraction of PG&E's boilers are over 30 years old, the capital recovery factor used above may have to be increased, thereby increasing the cost of control. Thus, while more detailed cost analyses will necessary, an average cost-effectiveness of about $18,000 per ton of NOx reduced would appear to be reasonable. A utility-wide average NOx limit of 0.25 lb NOx/MW-hr should be achievable at that cost.

Other Impacts

Combustion modification NO_X controls should not have any significant impacts on emissions of other pollutants or on boiler operation. NOx reductions in general, including those associated with the proposed control measure, can cause localized increases in ozone concentrations.

The SCR and ammonia injection processes involves the use of ammonia. Ammonia is a toxic compound and its production, use, storage, and transport can be hazardous. Worker or public health could be impacted in the event of an accidental release or spill. Low level operating emissions from "ammonia slip" are possible (up to 10 ppm), but would probably be insignificant. Some increase in truck traffic, and the associated vehicle emissions can be expected due to the delivery of raw ammonia. The accidental release of ammonia could also adversely affect water quality.

For boilers firing high sulfur oil, the ammonia-based flue gas treatment processes may produce ammonium bisulfate, a compound that can contribute to boiler economizer and/or air preheater fouling as well as increased particulate emissions. These deposits are usually removed from the SCR system using water or steam soot blowing techniques. This on-site catalyst regeneration could affect water resources, however, these problems should not develop because, as noted above, PG&E does not intend to burn high-sulfur oil.

The proposed control measure would result in solid waste impacts from disposed SCR catalysts. These catalysts typically have a lifespan of 2 to 7 years, depending on the type of fuel used, impurities in the fuel, and the NO_X emission reduction efficiency required. When the spent catalyst is disposed of, several cubic yards of solid materials which may be considered hazardous, would require proper handling and disposal. Catalyst modules should, however, be regenerable by the manufacturer.

Because of the narrow and specific temperature window required with ammonia/urea injection, that technique may limit boiler load range capability. No such restriction is expected for SCR.

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CM# D4: CONTROL OF EMISSIONS FROM BOILERS, STEAM GENERATORS AND PROCESS HEATERS

Background

This control measure would reduce NO_x emissions from industrial boilers, steam generators and process heaters by establishing NOx standards for these sources. In most instances, the proposed NOx limits are expected to be achieved with combustion modifications. The typical source would require low-NO_x burners in combination with flue gas recirculation (FGR). It is anticipated that the control measure would affect sources rated 5 million (MM) BTU/hr or greater.

The facilities affected would be refineries, chemical plants and many other industrial, commercial and institutional facilities with combustion equipment used to produce steam or transfer heat to process streams (kilns and ovens are generally not considered "process heaters"). Most of the affected sources are currently equipped with conventional burners with NOx emission levels ranging from 100 ppm to 150 ppm.

Regulatory History

Currently, the District does not specifically regulate NOx emissions from most existing boilers, steam generators or process heaters, except for very large units. District Regulation 9, Rule 3, has NOx emission limits of 125 ppm for gas-fired, and 225 ppm for oil-fired heat transfer operations with a maximum heat input of 250 MMBTU/hr or more. These standards apply to equipment permitted after April 19, 1975. Older units must meet NOx limits of 175 ppm and 300 ppm for gas and oil-firing, respectively, but only if the maximum heat input is 1.75 billion BTU/hr or more.

All fossil-fuel-fired steam generators for which construction is commenced after August 17, 1971, are also subject to the requirements set forth in the NSPS standards found in CFR, Part 60, Chapter 1, Title 40, SubPart Da which was passed on June 14, 1974, and amended on August 4, 1987. In addition, there is a SubPart Db which was passed on November 25, 1986 and amended on December 16, 1987, which covers industrial, commercial and institutional steam generating units.

Currently, the most stringent District requirements for boilers and other similar combustion sources are for new/modified units that are subject to the District's NSR Rule. Projects with NOx emissions which exceed 150 lb/day or 25 TPY (cumulative increase) must meet stringent BACT requirements.

All industrial boilers, steam generators and process heaters require permits except where they are fired exclusively on natural gas and/or liquefied petroleum gas, and are less than 10 MMBTU/hr firing capacity. Otherwise, the permit exemption is one million BTU/hr or less.

The South Coast AQMD currently regulates the emissions from industrial, institutional, and commercial boilers, steam generators, and process heaters under SCAQMD Rule 1146, which was adopted on September 9, 1988. The SCAQMD Rule establishes a NOx limit of 0.05 lb/MMBTU of heat input (40 ppm) for units rated 5 MMBTU/hr or greater and with an annual fuel usage greater than 9000 MMBTU/yr.

Emissions Subject To Control

The affected source categories are *oil refineries -- external combustion* for refinery make gas, natural gas, liquid fuels, and solid fuels; and *other external combustion* for gas, oil and other fuels. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	47.6
1997	48.8
2000	49.9

Proposed Method Of Control

NOx limits similar to those specified in SCAQMD Rule 1146 are proposed for the Bay Area. A general NOx limit of 30 ppm (0.036 lb/MMBTU) is proposed for equipment fired on natural gas/or LPG with a firing rate of 5 MMBTU/hr or greater. It is proposed that units fired on fuel oil meet a 40 ppm (0.048 lb/MMBTU) NOx limit. (The proposed concentration limits are at 3 percent oxygen, by volume).

The predominant control technology used to achieve the 30 ppm on gaseous fuels is expected to be state-of-the-art low-NO_x burners in combination with FGR. In some cases, other combustion modifications such as low excess air or staged combustion (e.g. overfire air ports) may also be necessary.

In certain instances, combustion modifications alone may not be adequate to meet the proposed NOx limit, and flue gas treatment may be necessary. Post-combustion flue gas treatment can be used to destroy NO_x after it is formed; these technologies include (1) selective non-catalytic reduction (SNCR), e.g. ammonia or urea injection or (2) selective catalytic reduction (SCR). Both technologies lower NO_x emissions by using a reducing agent, ammonia or urea, to reduce the NO_x molecules to nitrogen and water. While ammonia/urea injection and SCR can achieve up to 50 percent and 90 percent NO_x reduction, respectively, their complexities and operating costs are significantly higher than those of combustion modification techniques.

The SNCR process selectively reduces NO_x with injection of ammonia or urea into the flue gas at temperatures ranging from 1600^oF to 1800^oF without a catalyst. The SNCR method, while reducing NO_x up to 50 percent, is very temperature sensitive and is limited to the temperature window indicated. Typically, the reducing agent is injected into the economizer section of the boiler. However, boiler-specific retrofit installation restraints may be encountered.

SCR uses a catalyst to lower the required temperature of NO_x reduction to less than 800^oF, achieving up to 90 percent NO_x reduction. The SCR reactor is typically installed downstream of the boiler economizer and upstream from the air preheater.

A compliance schedule based on boiler size is anticipated for this control measure. A low fuel-use exemption, and a provision allowing compliance to be demonstrated within a facility "bubble", will also be considered.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the NOx emissions from affected sources would be reduced by 70 to 80 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	33.3	38.1
1997	34.1	39.1
2000	34.9	39.9

Costs of Control

The actual costs of control will be quite boiler specific. The SCAQMD has estimated that the cost-effectiveness of SCAQMD Rule 1146 ranges from $2000 to $19,000 per ton of NOx reduced, with average costs of $6800 per ton of NOx reduced. SCAQMD Rule 1109, which covers refinery boilers and heaters is estimated to have an average cost-effectiveness of $9000 per ton of NOx reduced. The cost to retrofit some older vintage boilers and boilers of atypical designs may be 2 to 3 times higher.

Other Impacts

Combustion modification NO_x controls should not have any significant impacts on emissions of other pollutants, or on combustion equipment operation. NOx reductions in general, including those associated with the proposed control measure, can cause localized increases in ozone concentrations.

Flue gas NOx controls will typically not be needed as a result of this control measure. When used, however, SCR and SNCR control technologies may create impacts from ammonia emissions. Ammonia is a toxic compound and its production, use, storage, and transport can be hazardous. Worker or public health could be impacted in the event of an accidental release or spill. Low level operating emissions from "ammonia slip" are possible (up to 10 ppm), but would probably be insignificant. Some increase in truck traffic, and the associated vehicle emissions can be expected due to the delivery of raw ammonia.

The proposed control measure could adversely affect local water resources as a result of regenerating SCR catalysts. For boilers using fuels with a high sulfur content and having a high ammonia slip, the use of SCR for NO_x removal may cause ammonium bisulfate and/or ammonium sulfate deposits to form downstream from the unit reactor, producing plugging and corrosion. These deposits are usually removed from the SCR system using water or steam soot blowing techniques. Catalyst regeneration through washing would create wastewater requiring proper handling and treatment to avoid contamination of water resources.

References

SCAQMD Rule 1146: Emissions of NO_x from Industrial Boilers, Steam Generators and Process Heaters, October 1987.

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CM# D5: CONTROL OF EMISSIONS FROM CEMENT PLANT KILNS

Background

This control measure would reduce NOx emissions from portland cement manufacturing plants by establishing NOx standards for precalciner/kilns. This control measure would affect one plant, the Kaiser Permanente facility in Cupertino.

In 1977, a modernization program was begun at the Kaiser Permanente facility utilizing "state-of-the-art" technology for cement manufacturing. The modernized facility was completed and began operation in 1981. This cement manufacturing process is a relatively new type of dry process known as a four stage suspension preheater system. The precalciner/kiln used in this process is very effective in utilizing less fuel and maintaining lower NO_x levels per ton of cement produced than conventional kiln systems. This plant utilizes a special kiln burner and is designed to burn coal as a primary fuel and petroleum coke as a secondary fuel with natural gas as backup fuel.

The precalciner/kiln system differs from conventional methods in that the raw feed is approximately 85 percent calcined when it leaves the calciner and passes from the fourth stage into the kiln. About 60 percent of the fuel normally required in the clinkering process is used in the calcining reaction in the flash calciner. The remaining 40 percent of the fuel is provided to the rotary kiln as secondary combustion air for the final calcining and sintering reactions. In addition, heat from the hot clinker cooler is recovered and conveyed to the kiln as secondary air; a portion of the hot gases are ducted through a separate refractory-lined duct located parallel to the kiln and are combined with the hot combustion gases leaving the rotary kiln and sent to the calciner. This permits the fuel in the rotary kiln to be burned with preheated combustion air with minimum quantities of excess air (6-8 percent O_2), while maintaining optimum burning conditions in the kiln. When the proper balance of minimum excess air in the kiln and in the flash calciner is maintained, lower NO_x emissions are formed during the combustion process.

Regulatory History

Currently, the District does not specifically regulate NOx emissions from existing cement plant kilns. The most stringent District requirements for kilns and other combustion sources are for new/modified units that are subject to the District's NSR Rule. Projects with NOx emissions which exceed 150 lb/day or 25 TPY (cumulative increase) must meet stringent BACT requirements.

In 1981, CARB promulgated a Suggested Control Measure (SCM) for NO_x emissions from cement kilns. The South Coast AQMD adopted SCAQMD Rule 1112 which limited the emissions to 3.1 pounds of NO_x per ton of clinker; however, at no time was the objective limit achieved or even approached. As a result, the final emission limits were changed to 6.4 lbs/ton of clinker produced when averaged over any 30 consecutive day period.

Emissions Subject to Control

The affected source categories are *other external combustion* for gas, coke and coal fuels. Only a portion of the total emissions in these categories are from cement kilns. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	5.10
1997	5.47
2000	5.85

Proposed Method of Control

The precalciner/kiln at the Kaiser Permanente facility currently meets the NOx limits established in SCAQMD Rule 1112, as well as CARB's 1981 SCM, which were both intended for conventional cement kilns (existing emissions are about 1.8 pounds of NO_x per ton of clinker produced). Because the NOx emissions from this source remain significant, District staff has evaluated a number of additional potential NO_x reduction methods that may be applicable to the precalciner/kiln. It is believed that promising post combustion control methods exist that could potentially provide NO_x reductions of 50 to 60 percent in a cost-effective manner, although these technologies have not been successfully demonstrated on cement kilns at this time. The following control technologies have been investigated and are summarized below:

(1) Selective Catalytic Reduction, (2) Thermal DeNOx or Ammonia Injection, (3) Urea Injection and, (4) Cyanuric Acid Injection.

Selective Catalytic Reduction (SCR)

In this process, ammonia is injected into the hot flue gases in the presence of a catalyst to selectively reduce NO_x emissions. The catalysts allow the reaction to occur at temperatures between 550 and 800^oF. District investigations reveal that SCR has not been successfully used in applications with a dust-laden gas stream. Pretreatment of the gas stream with some type of particulate removal device would therefore be required with a reheat system to adequately increase the temperature for the NOx-reducing reaction to occur. Contamination of the catalyst bed is another unresolved problem. SCR is an unproven technology for this type of process and would probably have very high costs. Accordingly, this method is not considered a good candidate for implementation.

Ammonia and Urea Injection

Ammonia or urea injection technologies do not use a catalyst. These methods require optimum temperatures between 1400 and 1800^oF. In order to meet these temperature requirements, gas stream reheating would likely be necessary. Ammonia or urea injection are therefore not believed to be good candidates for implementation.

Cyanuric Acid

This proposed NOx control method is based on injecting isocyanic acid into the exhaust stream at temperatures above 750^oF without a catalyst. Isocyanic acid is formed from the thermal decomposition of cyanuric acid, a non-toxic commercially available compound (when cyanuric acid is heated above 650^oF, the compound breaks down to form isocyanic

acid). Isocyanic acid can potentially remove NO_X from a variety of combustion equipment (e.g. the technology has been successfully demonstrated on the exhaust from a diesel engine). This process is considered the most promising post combustion process for reducing NOx emissions from the Kaiser Permanente facility.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the average NOx emission reductions from this control measure would be 50 to 60 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	2.55	3.06
1997	2.74	3.29
2000	2.93	3.51

Costs of Control

A preliminary estimate of the costs of installing and operating a cyanuric acid injection system at the Kaiser Permanente precalciner/kiln were made. Capital costs considered included foundations, ducts, controls, piping and other direct facility costs including engineering design, supervision and fees, construction facilities, service facilities, initial charges and startup and performance tests.

The annual costs of the cyanuric acid injection system include raw material and operation and maintenance costs. The anticipated costs of control are listed below.

Capital Costs for Cyanuric Acid Injection

Equipment purchase costs:	$300,000
Accessory costs:	$100,000
Transportation and Sales Tax:	$25,000
Installation costs:	$200,000
Engineering cost (@ $50/hr):	$75,000
Contingency costs:	$15,000
Total capital costs:	$715,000

Annual Operation and Maintenance Costs

Raw Material costs:	$288,000
Electric power:	$36,000
Other utility costs:	$1,300
Maintenance cost (5% of equipment):	$60,000
Operator costs (@ $25/hr):	$50,000
Engineer costs (@ $50/hr):	$100,000
Waste processing costs:	$20,000
Total annual operating costs:	555,300

The cost-effectiveness of this control measure is estimated to be about $2000 per ton of NOx reduced.

Other Impacts

If cyanuric acid injection was used to control NOx emissions, no significant adverse environmental impacts would be expected, except for a slight increase in CO emissions.

If SCR or ammonia injection control technologies were used, potential impacts from ammonia emissions would exist. Ammonia is a toxic compound and its production, use, storage, and transport can be hazardous. Worker or public health could be impacted in the event of an accidental release or spill. Low level operating emissions from "ammonia slip" are possible (up to 10 ppm), but would probably be insignificant. Some increase in truck traffic, and the associated vehicle emissions can be expected due to the delivery of raw ammonia.

The use of SCR could also adversely affect local water resources as a result of regenerating catalysts. For combustion equipment using fuels with a high sulfur content and having a high ammonia slip, the use of SCR for NO_x removal may cause ammonium bisulfate and/or ammonium sulfate deposits to form downstream from the unit reactor, producing plugging and corrosion. These deposits are usually removed from the SCR system using water or steam soot blowing techniques. Catalyst regeneration through washing would create wastewater requiring proper handling and treatment to avoid contamination of water resources.

References

South Coast AQMD Rule Development Division, Staff Report - Control of Oxide of Nitrogen from Cement Kilns, January 17, 1986.

"Rapid Reduction of Nitrogen Oxides in Exhaust Gas Streams", R.A. Perry and D.L. Siebers, Nature Vol. 324, December 1986.

South Coast AQMD Rule 1112: Emissions of Oxides of Nitrogen from Cement Kilns, Amended June 6, 1986.

CM# D6: CONTROL OF EMISSIONS FROM GLASS MANUFACTURING PLANT MELTING FURNACES

Background

This control measure would reduce NOx emissions from container glass melting furnaces by establishing NOx standards for these sources. It is expected that the proposed NOx-limits can be met by combustion and process modifications.

There are five glass melting furnaces currently operating within the District. Three of these furnaces are operated by Owens-Brockway Glass Container, Inc. The other two furnaces are operated by Anchor Glass Container Corporation; one of these facilities is sited in Antioch, the other plant is located in Hayward. It is important to note that at least one of the five glass melting furnaces operating in the Bay Area currently complies with the emission limitation being considered.

Regulatory History

Currently, the District does not specifically regulate NOx emissions from existing glass melting furnaces. The most stringent District requirements for furnaces and other combustion sources are for new/modified units that are subject to the District's NSR Rule. Projects with NOx emissions which exceed 150 lb/day or 25 TPY (cumulative increase) must meet stringent BACT requirements.

In 1980, CARB promulgated a Suggested Control Measure (SCM) for NO_x emissions from glass melting furnaces. The SCM established an emission limit of 4.0 pounds of NOx per ton of glass pulled (withdrawn from the furnace). The South Coast AQMD adopted the SCM on February 5, 1982, in the form of a Demonstration Rule, SCAQMD Rule 1117. That rule was amended on January 6, 1984. The amended SCAQMD Rule 1117 specifies an emission limitation of 5.5 pounds of NOx per ton of glass pulled, effective January 1, 1988. The NOx limit drops to 4.0 pounds per ton of glass pulled, effective January 1, 1993.

During workshops held by the SCAQMD staff to formulate the regulatory limits and language, representatives for Brockway Glass stated that they could already meet a limitation of 4.0 pounds of NOx per ton of glass pulled.

Emissions Subject to Control

The affected source category is *other external combustion -- natural gas*. Only a portion of the total emissions in this category are from glass melting furnaces. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	4.70
1997	5.02
2000	5.34

Proposed Method of Control

The NOx limit specified in SCAQMD Rule 1117 (4.0 lb/ton) is proposed for the Bay Area. It is expected that existing furnaces will use combustion and process modifications to meet the proposed standards.

The modifications that can be implemented to reduce NOx emissions from glass melting furnaces are listed below. A facility may choose to implement one or more of these options as necessary to achieve the required NOx reductions.

(1) Increase the proportion of cullet (scrap glass) charged to the glass melting furnace.

(2) Increase the electrical boost used to achieve and maintain the molten state of the mix. Electrical boosting can provide from 10 to 75 percent of the furnace's heat requirement.

(3) Reduce the volume of excess air present for fuel combustion, thereby reducing the formation of NOx. Furnace operation at very low oxygen levels is best accomplished by continuous monitoring of flue gases, coupled with feedback to the inlet air controls.

(4) Improve furnace insulation.

(5) Briquetting and preheating of the feed mix will increase fuel efficiency, thereby reducing the NOx emissions.

(6) Select a burner design which causes less NOx emissions.

Some of these control options have the potential for significant NOx reductions. The remaining options may be used to achieve smaller reductions, where the current emissions are close to the standard being proposed. Each plant would employ only those modifications most suited to their specific furnace, based upon the amount of reduction required to come into compliance.

If this control measure is adopted, some source operations are likely to be exempt from its requirements. Examples of possible exemptions include:

(1) Flat glass melting furnaces.
(2) Idling glass melting furnaces.
(3) Furnaces used in the melting of glass for the production of fiberglass exclusively.
(4) Glass remelt facilities using exclusively glass cullet, marbles, chips, or similar feedstock in lieu of basic glass-making raw materials.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the average NOx emission reductions from this control measure would be 45 to 55 percent.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	2.11	2.59
1997	2.26	2.76
2000	2.40	2.94

Costs of Control

Information regarding the costs of control for this measure was taken from the staff report on the amended SCAQMD Rule 1117.

When the SCAQMD's Board of Directors considered reducing NOx emissions from glass melting furnaces as part of their 1982 AQMP, the process and combustion modifications proposed were estimated to cost $3400 per ton of NOx reduced.

The Glass Packaging Institute commissioned the firm of Peat, Marwick, Mitchell and Company to prepare an economic analysis of the South Coast AQMD's proposal. The results of that study, completed in July 1983, estimated the cost to reduce NOx emissions to be $5500 per ton reduced. That figure included capital costs, operating costs, maintenance costs, as well as the cost of obtaining money. The SCAQMD staff noted some discrepancies in the Peat, Marwick, Mitchell and Company report. These discrepancies lowered the reported cost for controlling emissions to less than $4000 per ton of NOx reduced.

The overall cost-effectiveness of this control measure is estimated to be about $4000 per ton of NOx reduced.

Other Impacts

Furnace heating is normally accomplished using natural gas as the fuel. Use of electric boost for supplemental heating would increase demand for electric power generated at power plants. No adverse impacts on either water quality or solid waste disposal are expected as a result of this control measure.

References

BAAQMD Source Test Report No. 91068, conducted October 16, 1990 at Owens-Brockway Glass Container, Inc. to determine the current level of NOx emissions from their three glass-melting furnaces.

SCAQMD Staff Report, Rule Development Division, 'Proposed Amended Rule 1117 - Emissions of Oxides of Nitrogen from Glass-Melting Furnaces', November 23, 1983.

SCAQMD Rule 1117, Adopted February 5, 1982, Amended January 6, 1984.

CM# D7: CONTROL OF EMISSIONS FROM RESIDENTIAL WATER HEATING

Background

This control measure would reduce NOx emissions from new gas-fired residential water heaters by establishing NOx emission standards for these sources. It is expected that the proposed NOx limits will be achieved by combustion modifications.

Residential water heaters are devices that heat water at a thermostatically-controlled temperature for delivery on demand. Combustion air is provided in a water heater by natural draft. The NOx emissions are functions of flame temperature and the combustion product cooling rate.

New water heaters sold in California currently must meet energy efficiency standards established by the California Energy Commission (CEC). In order to avoid penalizing energy efficient designs, emission standards for water heaters should be established on the basis of mass emissions per unit of useful heat output. This will allow a water heater to come into compliance either by reducing emissions per unit of energy input, increasing its efficiency, or both.

Regulatory History

The District currently does not regulate NOx emissions from residential water heaters.

South Coast AQMD Rule 1121, which limits NOx emissions from new water heaters to 40 nanograms per joule of heat output, has been in effect since January 1, 1984. In addition, the SCAQMD proposed, in their 1989 AQMP revision (CM #88-D-5) to require the installation of solar water heating equipment in all new residential multi- and single-family homes over 2,000 square feet, and in all new commercial buildings. On an annual basis, it was estimated that this requirement would result in about 50 percent less energy usage (and NOx emissions) compared to conventional water heating systems. Other control technologies capable of achieving equivalent NOx emission reductions may alternatively be allowed.

Emissions Subject To Control

The affected source category is *domestic water heating -- natural gas*. The projected NOx emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	7.94
1997	8.15
2000	8.37

Proposed Method Of Control

This control measure proposes to establish a 40 nanograms per joule (output) NOx limit for new residential hot water heaters, based on the existing SCAQMD Rule 1121. Combustion modification appears to be the only practical means of reducing NOx emissions from water heaters. A number of low-NOx burner designs capable of meeting the 40 nanograms per joule standard are currently commercially available.

A demonstration program, supported by the SCAQMD, is currently underway to produce a commercially viable water heater capable of achieving NOx emissions of less than 10 nanograms per joule. Although commercial introduction is expected by late 1993, a number of technical difficulties first need to be resolved before these very low NOx levels can be specified.

The use of solar heating systems can reduce natural gas consumption and NOx emissions simultaneously. The equipment and installation costs for retrofitting existing homes with solar water heating systems are, however, unacceptably high (based on SCAQMD estimates, over $300,000 per ton of NOx reduced). The costs of solar systems for new homes are lower; cost-effectiveness estimates cover a wide range depending on the assumptions made (based on SCAQMD estimates, cost-effectiveness ranges from a cost savings to costs of $62,500 per ton of NOx reduced). The suitability of requiring solar water heating for new residential buildings may be further considered during the rule development process.

Emission Reductions Expected

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the proposed 40 nanograms/joule NOx limit would reduce emissions from 40 to 50 percent.

The proposed control measure will apply only to new water heaters. Based on a useful water heater life of 10 years, the emissions subject to control are assumed to be 10 percent of the total category emissions in the first year of implementation (assumed here to be 1994). In successive years, the emissions subject to control are assumed to increase by an additional 10 percent per year, until all existing water heaters are replaced with complying units (in 10 years).

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions Low (TPD, Summer)	Emission Reductions High (TPD, Summer)
1994	.32	.40
1997	1.30	1.63
2000	2.34	2.92

Costs of Control

Residential water heaters present a major technical challenge to cost-effective emission control because of their low unit price. At the proposed NOx limit of 40 nanograms per

joule, the cost-effectiveness of this control measure is expected to be less than $2000 per ton of NOx reduced.

Other Impacts

No adverse environmental impacts are anticipated as a consequence of this control measure. The proposed NO_x controls should not have any significant impacts on the emissions of other pollutants or on water heater performance. Improvements in energy efficiency would reduce natural gas consumption.

References

South Coast Air Quality Management District, Control of Emissions from Residential and Commercial Water Heating, CM #88-D-5.

CM# D9: CONTROL OF EMISSIONS FROM RESIDENTIAL WOOD COMBUSTION

Background

This control measure would reduce emissions from domestic wood stoves and fireplaces by: (1) expanding public awareness programs, (2) requiring uncontrolled wood stoves to be removed or replaced by controlled stoves upon sale of real property, (3) placing restrictions on the sale and installation of used wood stoves, (4) accelerating the use of Phase II wood stoves, (5) possibly establishing a moisture content limit for "seasoned wood" and, (6) establishing a voluntary curtailment program (there is some overlap between this last measure and Control Measure G1, Citizen Postponement of Discretionary Activities). The control measure will primarily reduce the emissions of carbon monoxide (CO) and particulate matter (PM), although reactive hydrocarbon (RHC) emissions will be reduced as well.

Residential wood combustion sources include fireplaces and wood stoves (or heaters). Fireplaces are used for supplemental heating and for aesthetic effects. Fireplace combustion is characterized by high air-to-fuel ratios and burn rates. Traditional masonry fireplaces typically have large open fireboxes without combustion air controls. These fireplaces are usually inefficient heating devices -- during certain conditions, a net heat loss may occur in a residence as local radiant heat is offset by cold air drawn into the dwelling to replace air lost through the chimney draft.

Wood stoves are used primarily as domestic space heaters. Wood stoves have enclosed fireboxes and dampers to reduce air-to-fuel ratios and burn rates. Wood stoves typically have energy efficiencies ranging from 50 to 70 percent.

The emissions from residential fireplaces and wood stoves are highly variable depending on design characteristics, operating procedures and fuel properties. The emission factors given in EPA's AP-42 for conventional wood stoves are higher than those given for fireplaces by about 50 percent for PM and CO, and by over 200 percent for RHC (per ton of wood burned).

Regulatory History

The District currently has no specific requirements that apply to residential wood combustion, except for the EPA's Standards of Performance for New Stationary Sources (NSPS) for residential wood heaters, which is adopted by reference in District Regulation 10. The NSPS requires that new residential wood heaters, sold after July 1, 1990, be certified to meet specific PM emission limits. More restrictive emission limits apply to units sold after July 1, 1992. While the EPA emission limits have been set only for PM, the emissions of other pollutants associated with incomplete combustion (e.g. CO and RHC) are reduced as well.

On November 8, 1989, the California Air Resources Board (ARB) approved a Suggested Control Measure (SCM) for the control of emissions from residential wood combustion. A number of control strategies are recommended for reducing emissions from fireplaces and wood stoves. Each of the control strategies recommended in the SCM have been adopted by one or more jurisdictions outside of California.

Emissions Subject to Control

The affected source categories are *fuels combustion, solid fuel -- wood stoves* and *fireplaces*. The projected emissions subject to control for fireplaces are given below. Emission estimates for wood stoves were not available, due to insufficient information. The emissions from fireplaces are, however, expected to be much greater than the emissions from wood stoves in the Bay Area. The CO emission estimates are for the winter planning period; the RHC emission estimates are for the summer planning period.

Year	RHC Emiss. Subject to Control (TPD, Summer)	CO Emiss. Subject to Control (TPD, Winter)
1994	3.6	340
1997	3.7	350
2000	3.9	360

Proposed Method of Control

The control strategies recommended in the ARB's SCM are proposed for adoption in the Bay Area. Three of these measures are directed at accelerating the replacement of conventional wood stoves with units that have less polluting design features. Unfortunately, no similar proven emission control technologies currently exist for fireplaces. The SCM proposals are listed below.

1. Replacement of Non-Certified Wood Heaters Upon Sale of Real Property

This measure would require that, prior to the closing of escrow for any real property that contains a non-certified wood heater, the heater must be removed or made permanently inoperable, or be replaced or retrofitted with a certified unit. A program of this type is being implemented in Washoe County, Nevada.

Certified wood stoves include both catalytic and non-catalytic units. In laboratory conditions, certified wood stoves have been shown to have dramatically lower PM and CO emissions than conventional wood stoves. In "real-world" conditions the emission reductions are generally more modest, but still significant with average reductions ranging from 45 to 70 percent for PM and CO.

Certified wood stoves emit substantially less RHCs than conventional units. RHC emission reductions from certified wood stoves are on the order of 80 to 90 percent.

2. Acceleration of Implementation Date for EPA's Phase II Emission Standards for the Sale of New Wood Heaters

EPA's Phase II NSPS for new wood heaters becomes effective on July 1, 1992. If a rule implementing this control measure occurs prior to this date, it would specify that only Phase II heaters be sold.

3. Restrictions on the Sale and Installation of Used Wood Heaters

The NSPS does not restrict the sale and installation of conventional used wood heaters. This proposal would ban the sale of uncertified operable wood heaters.

4. Public Awareness Program Encouraging Cleaner-Burning Practices

Under this measure, wood heater retailers would be required to provide public awareness information with each retail sale of a solid fuel burning unit. This information would be in the form of pamphlets or brochures that describe the proper sizing, operation, maintenance, and fuel use for wood heaters, as well as information related to weatherization methods for the home and the health effects of wood smoke. This information is important, in that the emissions from wood burning devices can increase significantly when not used according to manufacturer's instructions.

5. Moisture Content Limit for "Seasoned Wood"

This measure would establish a moisture content limit of 20 percent by weight for firewood that is advertised to be "seasoned wood". The use of seasoned wood in fireplaces can reduce emissions by a factor of two.

6. Voluntary Curtailment -- "No Burn Days"

The District will request voluntary curtailment of residential wood burning during forecast air pollution episodes. This measure is described in more detail in the report for CM# G1, Citizen Postponement of Discretionary Activities.

The effectiveness of a voluntary episode curtailment program is difficult to predict. A similar program implemented in Missoula, Montana was estimated to reduce residential wood burning emissions by 6 to 12 percent.

Emission Reductions Expected

The emission reductions for this control measure have not been quantified at this time.

Costs of Control

The requirements to replace conventional wood heaters with certified units is expected to result in a net cost savings. EPA estimates that the average price of a complying wood heater is $120 to $200 (1987 dollars) more than a conventional wood heater. The cost of retrofitting a conventional wood heater ranges from $125 to $250, according to ARB. Catalytic units also require catalyst replacement after about 10,000 hours of operation, at a cost of $50 to $75. In most cases, however, because these new heaters are more efficient than the models they replace, these excess costs will be recouped because of reduced fuel use. The ARB estimates that about $70 per year would be saved, assuming an average wood consumption of 1.9 cords per year.

The wood burning curtailment program is also expected to have positive economic impacts. Natural gas is the primary fuel used for space heating in the Bay Area. Because the cost of natural gas is generally less than the cost of wood (on a BTU basis), a homeowner will benefit by using a gas furnace versus a wood stove. Because fireplaces are generally energy inefficient, the economic benefits of heating with gas versus burning wood in a fireplace are quite significant (unless a very inexpensive source of wood fuel exists).

Wood retailers that do not represent wood to be "seasoned" will not be subject to wood moisture limitations. ARB estimates the costs of wood moisture measuring devices to be about $300.

The overall cost-effectiveness of this control measure has not been determined at this time.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. In addition to reducing CO and RHC emissions, PM emissions will be reduced. Wood burning is believed to be a significant contributor to ambient PM_{10} levels during episode conditions. PM emissions from wood burning can also cause public nuisance problems.

The emissions of polycyclic organic material (POM), a class of potentially toxic compounds some of which have been classified as probable human carcinogens, will be reduced as a result of the proposed control measure. The two primary contributors to ambient POM levels are mobile sources and residential wood combustion.

The accumulation of creosote in chimneys will be reduced by the replacement of conventional wood stoves with certified units. A 10 to 35 percent reduction in creosote accumulation has been observed with the use of certified wood stoves. Creosote deposition is the principal cause of chimney fires.

References

A Proposed Suggested Control Measure for the Control of Emissions from Residential Wood Combustion, CARB, October 1989.

Evaluation of Low-Emission Wood Stoves, Shelton Research, Inc., Report to CARB, June 1986.

Particulate Emission from Residential Wood Combustion, Roy F. Weston Co., DOE/OR/21389-T8, 1988.

The Northeast Cooperative Woodstove Study, OMNI Environmental Services, Report to EPA, EPA/600/7-87/026a, Nov. 1987.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

E. OTHER INDUSTRIAL/COMMERCIAL PROCESSES

CM# E1: CONTROL OF EMISSIONS FROM RUBBER PRODUCTS MANUFACTURING

Background

This control measure would reduce RHC emissions from rubber products manufacturing by requiring control of emissions from curing and molding processes and from cementing operations.

Natural and synthetic rubbers are polymeric materials possessing elastic properties. The commercially important rubbers are natural rubber and a considerable number of synthetics, such as styrene butadiene rubber (SBR), nitrile, butyl, neoprene, "stereo" rubbers, and polyurethanes. Currently, over half the synthetic rubber produced in the United States is used for manufacturing tires.

Synthetic rubbers are produced in either liquid (latex) or solid (crumb) form. A generalized synthetic rubber formulation and the functions performed by the ingredients is: (a) rubber (basic ingredient), (b) pigments (diluting, hardening, reinforcing),
(c) softeners (aiding processing, plasticizing, solvent proofing), (d) vulcanization agents (cross-linking), (e) accelerators (accelerating cross-linking reaction), (f) activators (controlling vulcanization) and, (g) any of a number of ingredients performing special functions such as coloring, flexibility, and retarding deterioration.

RHC emissions from the synthetic rubber manufacturing process consist of emissions from reactors and blow-down tanks, and mixing and drying operations. Fugitive emissions also occur from molding and curing processes when vulcanized rubber products are taken out of curing ovens or presses. Such emissions probably consist of decomposition products of organic additives or reaction products formed in the vulcanization process. Organic solvent-based cements are also widely used in rubber tire manufacturing and recapping operations.

There are currently no major rubber product manufacturing plants operating within the District. However, there are seven small tire recapping facilities and about seven specialty rubber product plants involved in the manufacturing of flexographic rollers, medical gloves, tubings, and wire insulations.

Regulatory History

At the present time, the District does not have a specific rule directed at reducing RHC emissions from rubber products manufacturing operations. District Regulation 8, Rule 21, limits RHC emissions from rubber tire manufacturing operations, but the Rule does not apply to tire recapping. No facilities within the District are currently subject to Rule 8-21. The various rubber products manufacturing operations located in the District are subject to the general requirements of Rules 8-2 and 8-4.

The South Coast AQMD has proposed stringent controls for rubber products manufacturing in their 1989 AQMP revision (CM #88-C-4).

Emissions Subject To Control

The affected source category is *rubber products manufacturing*. The projected RHC emissions from this category are listed below. This control measure would affect only a portion of the emissions within this category. Because the emissions from the affected sources have not yet been determined, the emissions subject to control are considered unknown.

Year	Category Emissions (TPD, Summer)
1994	2.16
1997	2.38
2000	2.46

Proposed Method Of Control

The RHC emissions from tire recapping operations are largely associated with rubber cement adhesive application and curing operations. The adhesive is usually applied on the tire in a booth or in a vented station. To control the RHC emissions, the adhesive application area could be enclosed and vented to a control device such as an incinerator or a carbon adsorption system. The other option for reducing the RHC emissions would be to develop and use low-VOC adhesives. This measure could be implemented by removing the retread operations exemption from Rule 8-21.

The RHC emissions from miscellaneous rubber product manufacturing are more difficult to control due to the wide diversity of manufacturing process. Fugitive RHC emissions are expected to be most significant in the molding and curing processes. The fugitive emissions, both in particulate and gaseous form, can be reduced by means of pick-ups installed in proper locations. A control system consisting of an electrostatic precipitator (ESP) followed by a carbon adsorber could be used to reduce emissions from these sources. The ESP would serve as a pre-treater to remove the particulates from the effluent to avoid plugging of the carbon bed.

Emission Reductions Expected

The types of abatement devices that are expected to be used for reducing RHC emissions from rubber products manufacturing operations typically have control efficiencies in excess of 90 percent. The overall emission reductions from fugitive sources would not be expected to exceed 80 percent due to collection system inefficiency. Because the emissions subject to control have not yet been quantified, emission reduction estimates are currently not available.

Costs of Control

The South Coast AQMD has estimated the cost-effectiveness of their rubber products manufacturing control measure to be $5600 per ton of RHC reduced. This figure is based on the cost of installing and operating a carbon adsorption system with an air inflow rate of 5000 cfm.

Other Impacts

In addition to controlling RHC emissions, this control measure should result in reductions in particulate matter emissions.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

The use of a carbon adsorption system could result in emissions of NO_x and CO from the combustion of natural gas to generate steam for stripping the solvent from the carbon bed. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of natural gas to generate steam for the stripping the of the carbon beds.

References

U.S. Environmental Protection Agency, EPA-600/2-77-023i, 1987.

The Encyclopedia of Chemistry, third edition, Hampel & Hawley.

CM# E3: CONTROL OF EMISSIONS FROM COMMERCIAL CHARBROILING

Background

This control measure would reduce RHC emissions from commercial charbroiling operations by setting standards for these sources. The emissions of PM_{10} would also be reduced. The primary method of control will be the installation of add-on exhaust controls. The replacement of conventional charbroilers with grooved griddles is another control option.

Charbroiling refers to the direct-firing method of cooking meat on a grated grill. Charbroilers consist of three principle components: (1) a grill, (2) a heating source and, (3) a high temperature radiant surface. RHC (and particulate matter, PM) emissions from charbroilers occur when grease from the cooking meat falls onto the heated radiant surface.

There are believed to be over one thousand full service and fast-food restaurants located within the District which use charbroilers to cook hamburger patties, chicken, steaks, and other foods.

Regulatory History

The District currently does not have a specific rule directed at reducing the RHC emissions from commercial charbroilers. Charbroilers must comply with District Regulations 6 and 7 regarding visible emissions and odorous substances, respectively, and with Regulation 1 regarding public nuisance. Because of these requirements, some existing facilities employ abatement devices to reduce emissions, although the emissions from most charbroilers are essentially uncontrolled.

The South Coast AQMD has adopted a control measure directed at reducing the emissions from commercial charbroilers in their 1989 AQMP revision (CM #88-C-3).

Emissions Subject to Control

The affected source category is *other industrial/commercial -- cooking*. Eighty percent of the emissions in this category were assumed to be affected by this control measure. The projected emissions subject to control are given below.

Year	Emissions Subject to Control (TPD, Summer)
1994	1.18
1997	1.29
2000	1.41

Proposed Method of Control

The primary control option for reducing RHC emissions from commercial charbroiling operations is add-on exhaust controls. RHC control devices applicable to charbroilers include adsorbers and afterburners. In most cases, grease particle emissions need to by controlled upstream of the RHC control unit. This can be accomplished by grease

extracting exhaust hoods (generally required to meet building and/or fire codes) and/or electrostatic precipitators (ESPs). Add-on control systems are available to reduce RHC emissions in excess of 90 percent. Significant reductions in PM_{10} emissions would also occur due to the necessary control equipment.

In some cases, the use of grooved griddles may be an acceptable substitute for charbroiling. Grooved griddles impart a similar appearance and flavor on certain meats, and are believed to have much lower RHC and PM emissions than charbroilers.

Emission Reductions Expected

It was assumed that this control measure would reduce RHC emissions from affected sources by 90 percent.

The estimates below show the emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	Emission Reductions (TPD, Summer)
1994	1.26
1997	1.37
2000	1.50

Costs of Controls

The South Coast AQMD has estimated the cost-effectiveness of a charbroiler control system consisting of an efficient grease extractor, an ESP and an adsorption-filter system to be about $25,000 per ton of RHC reduced.

Other Impacts

No significant adverse environmental impacts are expected as a result of this control measure. A reduction in particulate matter emissions and the emissions of odorous substances will result from this measure. Self-cleaning control systems should reduce fire hazards caused by grease build-up in the exhaust systems. Increased use of grooved griddles, which require less ventilation than charbroilers, would save on energy costs.

Where RHC emissions are controlled by incinerators, an increase in natural gas consumption will occur. The use of thermal or catalytic incineration to control RHC emissions, may result in emissions of CO, NOx or other criteria air pollutants. There is also the possibility of minor increases in certain of the greenhouse gases (CO_2 and NO_2) due to the combustion of organic compounds and the use of natural gas in the thermal oxidation abatement devices.

Where carbon adsorption systems are used to control RHC emissions, the activated bed eventually becomes "spent" and must be re-activated or disposed of at a licensed treatment storage and disposal facility (TSDF). Disposal of spent carbon adsorption filters may negatively impact solid waste disposal sites due to increased quantities of wastes. Spent carbon needs to be replaced or regenerated every 5 to 10 years. Spent carbon that is

regenerated by injecting steam through the carbon bed may result in traces of solvent in wastewater after the steam/solvent mixture has been processed. However, wastewater impacts will be insignificant if generators comply with federal, State and local regulations.

References

South Coast AQMD, 1989 AQMP Revision, CM #88-C-3.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

F. OTHER STATIONARY SOURCE CONTROL MEASURES

CM# F1: IMPROVED NEW SOURCE REVIEW RULE

(NOTE: THIS CONTROL MEASURE WAS ADOPTED ON JULY 17, 1991)

Background

The proposed amendments to the District's New Source Review (NSR) Rule, Regulation 2 Rule 2, are intended to make the permitting program comply with the no net increase requirement of the California Clean Air Act and Federal Law, as stated in the Code of Federal Regulations.

In order to assure that no net increase of any nonattainment pollutant or their precursors will occur, as the result of new permitting activities, it is proposed to reduce the BACT and offset thresholds to near zero for all new and modified sources of ozone precursors RHC and NOx, and carbon monoxide.

Regulatory History

The District adopted its first permitting regulation effective July 1, 1972. This regulation was modified in 1977 requiring the use of BACT for large new/modified sources.

BACT is currently required for new/modified sources which, on any single day, emit more than 150 lbs/day of precursor organic compounds, nitrogen oxides, sulfur dioxide, particulate matter, or more than 80 lbs/day of PM_{10}, or more than 550 lbs/day of carbon monoxide.

BACT is also triggered when the cumulative emissions from new/modified sources at a facility exceed 25 tons/year for precursor organic compounds, nitrogen oxides, sulfur dioxide, particulate matter, or more than 15 tons/year of PM_{10}, or more than 550 tons/year of carbon monoxide.

On May 21, 1980, the District amended the New Source Review Rule to require emission offsets be provided for cumulative emission increases of greater than 40 tons/year of RHC and 100 tons/year of NOx. These offset thresholds have rarely been exceeded due in part to the extensive use of BACT, but also due to their relatively high values.

The workshop process, required to consider amendments to the NSR rule, was begun in April of 1991. Final adoption of this control measure is expected to occur in July of 1991.

Emissions Subject To Control

The affected emissions for this control measure have not been quantified at this time.

Proposed Method Of Control

After adoption of this control measure, an applicant for almost any new or modified source must propose to utilize control technology which is judged to be "BACT" by the District before an Authority to Construct can be issued.

The District will prepare a comprehensive BACT list, similar to the one developed by the South Coast AQMD, which will be made part of the Manual of Procedures (MOP). This BACT document will be reviewed and revised as often as deemed necessary by the APCO, but not less than annually, in order to insure that the most effective control levels are required.

Offsets will also be required for most new or modified sources of RHC and NOx. The District staff will propose that offset ratios no longer be based on distance, but instead, be dependent on the magnitude of the total emission of a given pollutant from the facility.

Emission Reductions Expected

The emission reductions for this control measure have not been quantified at this time.

Costs Of Control

The costs, related to the use of BACT and the requirement to provide offsets, are expected to vary greatly depending on the specifics of the source and the pollutant subject to control.

The District will consider cost-effectiveness and technological feasibility when determining BACT for all sources not previously subject to this requirement.

Offset costs are even harder to estimate at this time, due to their limited supply and availability. The burden of providing offsets is expected to be particularly difficult for "greenfield" projects proposed by companies with no existing facilities in the District and for facilities with emissions less than ten tons per year. The District anticipates, however, that the cost of offsets will be a market driven commodity subject to the law of supply and demand.

Other Impacts

Except for relatively small emissions which may result due to the energy consumption of additional controls required by this measure, no adverse environmental impacts are expected as a result of the adoption of this control measure.

References

California Clean Air Act Permitting Program Guidance for New and Modified Stationary Sources in Nonattainment Areas, California Air Resources Board, Stationary Source Division, dated July, 1990.

Staff Report, Proposed Amended Regulation XIII-New Source Review, South Coast AQMD, dated May 11, 1990.

Concepts of A No Net Increase Permit Program, by Peter Hess, dated September 17, 1990.

CM# F3: PROMOTION OF ENERGY EFFICIENCY

Background

This control measure would establish a goal of increasing energy efficiency within the District by a specified amount. Unlike most other control measures, this one does not involve modifying an existing rule regarding emission control standards for specific equipment. Instead, it is more a conceptual approach at this time, first requiring review of many types of equipment used in residential, commercial and industrial settings. From this evaluation ("pre-rule") stage, individual rules can be developed afterward, for those types of equipment having the most promising emission reduction possibilities.

Energy needs and requirements in modern California society are ubiquitous: they are important elements in such varied products, functions and activities as personal and mass transit vehicles, residential ambient temperature control and lighting needs, industrial production operations and pollution abatement equipment. Consequently, the wide, general range of applicability of this control measure could result in a myriad of specific rules applicable to a multitude of specific applications.

State legislation currently provides for certain State agencies to have designated responsibilities to address California's energy needs and develop and implement energy efficiency standards. State legislation also has established the role of local air pollution control agencies in addressing the air quality problems in the parts of the State where they have jurisdiction. There is not yet established an integrated State-wide approach to deal with energy needs, energy efficiency standards, and air quality issues in a unified manner. On the local level, however, progress has been made in this area by the South Coast Air Quality Management District (SCAQMD).

Recognizing the time-consuming, technically-complex and jurisdictionally-interlocking nature of the issues faced, that agency established, more than a year ago (around August, 1989) an Energy Working Group (EWG). The objectives of the EWG are: (1) to examine the energy-related issues raised in the Air Quality Management Plan which the SCAQMD adopted earlier that year, (2) to establish technical consensus on solutions to energy-related air quality problems and, (3) to provide input to the 1991 Air Quality Plan, required under the California Clean Air Act. The EWG consists of a Steering Committee and four Subgroups. It was understood that achieving these objectives required, in order to develop needed policy decisions, the involvement of certain other agencies at the highest level. Therefore, the Steering Committee was established with membership consisting of a board member or commissioner and the executive officer of the following public agencies:

- California Air Resources Board (CARB)
- California Energy Commission (CEC)
- California Public Utilities Commission (PUC)
- SCAQMD
- Southern California Association of Governments (SCAG)

The four subgroups are:

- Electricity Demand and Supply
- Stationary Source Fuel Use and Availability
- Transportation Fuel Use and Availability
- Energy Conservation

The functions of the Steering Committee are to establish policy guidance, determine the need for technical analysis, select Subgroup membership and workplans, and make recommendations to the constituent agencies. Consequently, recommendations consider the statutory authority of each of the member agencies.

Regulatory History

Under the California Clean Air Act enacted by the State legislature, the Bay Area Air Quality Management District (BAAQMD) has authority to develop, adopt and enforce emission control regulations relating to attainment and maintenance of State ambient air quality standards. The Act also provides the BAAQMD with authority to develop indirect source control programs as part of the 1991 Clean Air Plan. Independently, State legislation provides the PUC (essentially a regulatory implementing agency) with authority to set rates that privately owned utilities may charge, oversee their operations and decide the amount, type and time when new energy resources will be built by the utilities. State legislation also provides the CEC (essentially a planning agency) with authority to forecast energy demand and conservation potential, determine existing supply, recommend energy policies to the PUC including siting locations for new facilities, and develop and implement building and appliance efficiency standards.

Consequently, the multi-agency jurisdictional nature of the subject control measure is evident.

Emissions Subject to Control

Most stationary source combustion categories including *power plants* could be affected by this control measure. The affected emissions for this control measure have not, however, been quantified at this time.

Proposed Method of Control

At this time, the control measure is in the "pre-rule" stage and so the proposed method of control cannot be determined. In reality, many more than a single method of control may be the ultimate outcome. First, further effort by the BAAQMD, along the lines of the SCAQMD, would be needed, including analysis of the multitude of products, functions and activities with an energy component. From this, a "control measure sub-set" of measures could be developed, each addressing the promotion of energy efficiency for the specific product, function or activity covered. Preparation work for each such "sub-set" measure could include estimation of potential effectiveness and control costs.

The global environmental impact of the thrust of this control measure may be an element in any further work on it. It was noted by the Executive Officer of the SCAQMD that though carbon dioxide is not a regulated pollutant, that agency is examining the potential impacts of the air quality plan on its production.

It has been suggested that air impact fees for indirect sources (IS) is an approach that might be instituted by a government agency to whom the District grants authority to administer an IS program. The purpose would be, for example, to provide an incentive for the sponsor of a development project to produce a project that is beneficial to the ambient air environment. There may be areas that the District itself can use fees to encourage the use of energy efficient equipment, though this may require legislative changes.

For example, the District might, for every permit application or only those which meet specified parameter threshold values, require that fuel- or energy-using devices (i.e., those devices burning fuel at the plant site or using electricity) be evaluated for energy efficiency. A permit fee schedule tailored to energy efficiency could possibly be established, with lowered fees established for the more energy-efficient devices. One approach would be to adopt a simple "BTU-tax" on all energy consuming sources, which would encourage the use of energy efficient equipment. If this could be done, the District might be among the first in the nation to employ such a tactic.

Emission Reductions Expected

The emission reductions for this control measure have not been quantified at this time.

Costs of Control

The costs of this control measure have not been quantified at this time. They would depend on each specific "sub-set" measure developed.

Other Impacts

It is not possible to determine, at this time, whether there may be unexpected adverse impacts from this control measure. At first glance, however, it does not appear that there would be any resulting from the development of any specific "sub-set" measure. However, there may be institutional and societal resistance to non-traditional control measures proposed to be undertaken by the District, especially where legislative authority is now lacking and would need to be obtained. State agencies with more established legislative authority, in these areas, might be able to implement the desired programs or work with jointly with the District in this regard.

The obvious positive impacts of this control measure are the savings in energy, particularly the reductions in fossil fuel use.

References

"Energy Efficiency as a Coordinated Environmental and Energy Strategy, Draft Phase I Report: Defining the Issues and Problems", Joint Committee on Energy Regulation and the Environment, April, 1990, pp. ii-1, ii-2.

"Energy Working Group Report", Staff Draft, prepared around September, 1990.

"Indirect Source Control Program", Issue Paper # 5 (Draft, 'Bay Area '91 Clean Air Plan (CAP)', BAAQMD), October, 1990.

"Increasing Energy Efficiency to Improve Air Quality", Remarks to the California Legislature Joint Committee on Energy Regulation and the Environment", October 1, 1990.

"Planning the Management of Global Air Pollution Issues - A Strategy for Air Pollution Control Agency Action", Presentation at the Air and Waste Management Association's 82nd Annual Meeting, Paper 89-39.7, June, 1989.

CM# F4: ENHANCED ENFORCEMENT OF EXISTING REGULATIONS

Background

This control measure would reduce emissions by improving enforcement practices which will lead to lower rates of non-compliance. This control measure could potentially be directed at any existing regulation. Because the District is classified as non-attainment for ozone ambient air quality standards, and the District's control strategy has primarily been focused on control of emissions of precursor organic compounds, the focus of this control measure would be those sources affected by rules in the District's Regulation 8.

The success of any regulation depends on the degree to which affected sources are able and are willing to comply. Many Regulation 8 rules require business decisions about the use of new, often more expensive materials (such as coatings and solvents), the installation of technologically advanced equipment designed to reduce emissions (such as zero gap tank seals), and the possible installation of abatement equipment or improvement in operating practices. Enforcement of these regulations and the community perception that enforcement is consistent and pro-active constitutes a powerful incentive to drive these business decisions in favor of compliance.

Regulatory History

Many of the Regulation 8 rules were based on EPA Control Technique Guidelines (CTGs), published in the late 1970s and early 1980s. The CTGs typically set limits for industrial processes but did not specify methods of enforcement to ensure compliance with regulations. In 1981, the District's Enforcement Division developed a Regulation 8 Enforcement Strategy delineating the responsibilities of different District divisions for compliance determinations. In 1987, the California Air Resources Board Compliance Division conducted an audit of District programs and came up with a list of recommendations, some of which were already scheduled for implementation, to improve enforcement of District rules.

In 1988, upon the expiration of the 1977 amendments to the Clean Air Act, the EPA required the District to amend many Regulation 8 rules to conform them to EPA policy. These policies were outlined in "Issues Relating to VOC Regulation - Cutpoints, Deficiencies and Deviations", published on May 25, 1988. Issues directly relating to enforcement included the need for appropriate recordkeeping and the need to cite test methodology appropriate to the standards. In 1989, the EPA and the ARB published a "Phase III" Rule Effectiveness study conducted throughout California on the compliance status of the aerospace industry, and is currently finalizing another one for the can and coil industry. The aerospace study cited shortfalls in the intended emissions reductions due to violations, variances, improperly granted or implemented Alternate Emissions Control Plans, rule relaxations, and underestimated growth and baseline emissions errors (although the successful implementation of the rule arguably has nothing to do with baseline emission error or underestimated growth).

The District's Emissions Inventory calculates the achieved emissions reductions for source categories, and hence progress toward attainment based on how effective (on a percentage basis) a rule is, which, in turn, is largely dependent on the effectiveness of the enforcement of the rule.

Emissions Subject to Control

The affected emissions for this control measure have not been quantified at this time.

Proposed Method of Control

Methods of control could be widely variable under this measure. Several options are discussed below.

Option #1: Rule Development

This option would provide for increased accountability by affected sources subject to a given rule. Examples include recordkeeping requirements, emissions monitoring requirements, data reporting requirements, violation self reporting requirements and operations and maintenance plan requirements. This option could be implemented in the normal course of rule development.

Option #2: Restructuring Enforcement Staff Activities

This option would provide for more effective use of existing enforcement staff by concentrating activities on sources likely to be in violation. This has precedent in the newly implemented gasoline facility HIT program, increasing inspection frequencies for sources found to be in violation and decreasing frequencies for sources found to be in compliance. Another strategy would be to schedule inspection activity for major emissions sources just prior to or during ozone season to increase the likelihood of curtailing violations during this period.

Option #3: Enforcement Audits

This option would enhance options #1 and #2. District staff is currently conducting a field audit of organic liquids storage tanks similar to the audits conducted on the aerospace and can and coil industries. The results of this audit are expected to feed directly into pending amendments to Regulation 8, Rule 5, and may also dictate inspection policy for these sources. In some cases, an audit might consist of information requests from affected sources coupled with field inspection activity. An audit might be better conducted by an outside contractor using established parameters rather than existing enforcement staff.

Option #4: Increased Surveillance

This option would require an increase in enforcement staff, which would result in a greater inspection frequency for each source. As with option #2, this would increase the likelihood of uncovering and curtailing emissions within a shorter time period from their initial occurrence.

Option #5: Increased Penalties for Non-compliance

This option would attempt to deter conscious violations of District regulations through mandating higher penalties for violations. The California Health and Safety Code sets maximum penalties for violations; State legislative action would be required to increase these amounts. The District currently sets penalties under mutual settlement guidelines, the amount could possibly be adjusted according to emissions related severity of the violation.

Option #6: Increased Public Awareness of Standards

This option would attempt to make affected industry and/or the public aware of the standards of a particular regulation and how best to achieve compliance. The District has sent advisories to affected sources regarding upcoming compliance dates for many years and has recently implemented an informational brochure program on various aspects of District concerns. Enforcement personnel could develop mailing lists of affected industries and follow up with advisories to track effective dates promulgated by regulatory changes.

Emission Reductions Expected

Emissions reductions would come from lower rates of non-compliance, but are not possible to quantify at this time.

Costs of Controls

Costs would vary with options and, again would be difficult to quantify, although costs could be quantified on a program by program basis. The costs of each option are discussed below.

Option #1: The costs would be borne by affected industry. Costs would include extra labor to comply with recordkeeping requirements and, in the case of monitoring equipment, capital and operating costs.

Option #2: The cost could be negligible, as the option would result in a more efficient use of staff, however staff time would be required to set up each program and monitor the results to quantify emissions reductions.

Option #3: The cost would be minimal, but would require some additional staff time to implement.

Option #4: This would result in the greatest additional cost to the District. The effectiveness of an across the board staff increase without concurrent implementation of option #3 would be directly proportional to ratio of new to existing inspection staff.

Option #5: This would be a direct cost to affected industry. Costs to the District could increase as increased penalties would provide an incentive to litigate settlements.

Option #6: The cost would be similar to option #3, again depending on the how in-depth a program would be implemented.

Other Impacts

No adverse environmental impacts are expected as a result of this control measure. Reductions in the emissions of toxic air contaminants are likely to result due to increased compliance.

References

1981 Regulation 8 Enforcement Strategy, BAAQMD, R. Matson

"Phase III Rule Effectiveness Study for the Aerospace Industry", EPA, ARB

"Phase III Rule Effectiveness Study for the Can and Coil Industry", Draft Workplan, EPA, ARB.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

G. INTERMITTENT CONTROL MEASURES

CM# G1: CITIZEN POSTPONEMENT OF DISCRETIONARY ACTIVITIES

(NOTE: IMPLEMENTATION OF THIS CONTROL MEASURE BEGAN IN SEPTEMBER, 1991)

Background

This control measure would involve the voluntary curtailment or postponement of certain activities by the general public on forecast ozone exceedance days.

This control measure would affect the usage of several mobile and areawide emission sources. These sources include architectural coatings, off-road motorcycles, internal combustion lawn and garden equipment, motorized pleasure boats, and certain consumer products such as charcoal lighter fluid, pesticides, and aerosol products. The control measure will principally reduce emissions of organic compounds (RHC), although reductions of nitrogen oxides (NOx) and carbon monoxide (CO) emissions from combustion sources, including the affected mobile sources, will also occur. The measure could also be applied to fireplace usage during forecast CO excess days during the winter.

Potential emission reductions associated with decreased on-road motor vehicle usage have been included in TCM# 23.

Regulatory History

The voluntary curtailment or postponement of certain activities by the general public on forecast ozone exceedance days has not been previously pursued by the District. District Regulation 4, Air Pollution Episode Plan, does describe abatement actions and strategies that are implemented when defined episode levels are forecast. These defined episode levels are much greater than the ambient air quality standards. The proposed control measure would be implemented when ozone levels are forecast to exceed the State ambient ozone standard of 0.09 ppm.

The District has not experienced any Stage I advisory alert episode ozone levels since 1983. However, when these levels were experienced, procedures were implemented to notify the general public through the media about the episode and what precautionary actions should be taken. These actions included the curtailment of school athletic activities, unnecessary driving, strenuous exercise, etc. These advisories also encouraged particularly susceptible people, such as those with chronic lung diseases, to stay indoors.

The Ventura County Air Pollution Control District included a similar type of control measure in their 1979 Air Quality Management Plan. The measure was somewhat more encompassing in that it included the voluntary postponement of the agricultural application of pesticides. The program designed to implement the Ventura measure was terminated after a brief implementation period. The principal reasons for its termination were the lack of data to measure program effectiveness, and the fact that EPA could not approve any emission reduction credit for the measure as part of an attainment strategy because the program was voluntary, intermittent, and not legally enforceable.

The emission source categories affected by the measure are generally controlled through other District regulations, or through current or future CARB emission standards for vehicular sources. For example, the organic content of architectural coatings is limited by

District Regulation 8, Rule 3. Similarly, emission standards for new vehicles and engines are specified by CARB.

Emissions Subject to Control

A number of source categories are affected including most solvent-based structures coating and cleanup categories, certain consumer products categories (e.g. *hair spray -- aerosol*), *lawn and garden and other utility equipment*, *recreational boats* and *off-road motorcycles*. The projected RHC and NOx emissions subject to control are given below. It should be noted that there may be significant overlap between this control measure and others being proposed. The emissions subject to control given below only incorporate the effectiveness of control measures already adopted. The emissions from some of the affected source categories are expected to decrease over time due to implementation of new control measures.

Year	Emissions Subject to Control RHC (TPD, Summer)	Emissions Subject to Control NOx (TPD, Summer)
1994	75.7	4.65
1997	76.1	4.80
2000	76.3	4.95

Proposed Method of Control

On days when ozone concentrations are forecast to reach 0.09 ppm, an advisory would be issued to the print and electronic media. Forecasts are made a day in advance. That is, today's forecast would be for tomorrow. The advisory would indicate that ozone levels are predicted to exceed the level of the ambient standard and would ask the general public to postpone certain activities on the day the ozone level is predicted to exceed the State ambient ozone standard.

Specifically, the general public would be asked not to apply solvent-based architectural coatings (both indoors and outdoors), not to use off-road motorcycles or other types of recreational off-road vehicles, not to mow their lawns or use other types of internal combustion garden equipment, not to use motorized pleasure boats, and not to use pesticides, charcoal lighter fluid and possibly other specified consumer products.

This control measure could be implemented within a three to six month timeframe. This time would be needed to design the specific implementation program and to enhance media contacts. Public information materials explaining the citizen postponement program would also be developed.

Emission Reductions Expected

The extent to which the affected activities will actually be postponed by the measure can only be estimated in crude terms. In addition, if the activities are postponed rather than replaced with less polluting alternatives or totally abandoned, then no permanent emission reductions would be realized. Temporary emission reductions will be realized to the extent that activities are postponed.

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that the RHC and NOx emissions from most affected sources would be reduced by 10 to 20 percent during an advisory. The RHC emissions from aerosol products use were assumed to be reduced by 5 to 10 percent.

	RHC Reductions (Summer)		NOx Reductions (Summer)	
Year	Emiss. Reduced Low (TPD)	Emiss. Reduced High (TPD)	Emiss. Reduced Low (TPD)	Emiss. Reduced High (TPD)
1994	6.46	12.9	.47	.93
1997	6.48	13.0	.48	.96
2000	6.52	13.0	.50	.99

Costs of Control

There are really no costs associated with this control measure in the traditional sense of control costs. There will be costs associated with designing and implementing the program, although these costs are not expected to be great and most likely will be absorbed with existing District staffing and funding resources.

There are no direct capital or operating/maintenance costs associated with this measure. Estimating these cost savings would be speculative at best, particularly in light of the uncertain degree of postponement that will be realized.

Other Impacts

Energy savings would result from reduced vehicular use (off-road), reduced use of motorized pleasure boats, and reduced use of lawn and garden equipment. This energy savings would only be realized when the activity was forgone rather than postponed.

References

None.

CM# G2: INDUSTRIAL POSTPONEMENT OF ACTIVITIES DURING FORECAST OZONE EXCESS DAYS

Background

This control measure would affect specific, non-production related, industrial operations when the District predicts excesses of the State ozone air quality standard. These operations include: industrial maintenance coating, uncontrolled soil aeration, repairs of external floating roof seals, uncontrolled cleaning of storage tanks, marine tank vessels and tank cars, process vessel depressurization, fuel oil usage, and check out of stand-by engines. Industrial facilities will also be asked to voluntarily reduce the emissions from all other operations to the maximum extent feasible during these episode conditions.

The control measure will principally reduce emissions of organic compounds (RHC), although reductions of nitrogen oxides (NOx) and carbon monoxide (CO) emissions from combustion sources will also occur.

Regulatory History

The mandatory curtailment or postponement of certain activities by the general public, industry or agricultural operations has a basis in District Regulation 5, Open Burning, and Regulation 4, Air Pollution Episode Plans. Agricultural open burning is curtailed during days when the District anticipates poor ventilation which could lead to excessive pollution concentrations. The ambient levels of air contaminants which would trigger the action levels for industrial curtailment included in Regulation 4 have not been experienced since 1983.

In addition, District Regulation 8, Rule 44, includes an ozone day excess prohibition for marine vessel loading operations. This provision is applicable to loading operations until mandated vapor recovery systems have been installed.

Emissions Subject to Control

A number of source categories are affected including most solvent-based industrial maintenance coatings categories, certain storage tank categories, *marine vessel cleaning & gas freeing, refinery vessel depressurization*, and *reciprocating engines*. The projected RHC and NOx emissions subject to control are given below. It should be noted that there may be significant overlap between this control measure and others being proposed. The emissions subject to control given below only incorporate the effectiveness of control measures already adopted. The emissions from some of the affected source categories are expected to decrease over time due to implementation of new control measures.

Year	Emissions Subject to Control RHC (TPD, Summer)	Emissions Subject to Control NOx (TPD, Summer)
1994	4.49	.12
1997	4.60	.13
2000	4.71	.14

Proposed Method of Control

On days when the District predicts an excess of the State ozone AAQS, an advisory would be issued to the print and electronic media. Because forecasts are made a day in advance, industry would be able to adjust their schedules to defer the operation of subject sources. Special phone lines would be dedicated to those industries wishing to call the District. Another option would be for the staff to contact specific industries and advise them of the need to curtail operations. It is expected that, at least initially, this measure would only affect non-production related activities within those affected facilities. A regulation would be prepared to require affected industries to prepare a notification and deferred operations plan. Sources under permits would be conditioned.

Emission Reductions Expected

The extent to which emissions are reduced is limited by the compliance rate. In addition, if the activities are postponed rather than replaced with less polluting alternatives or totally abandoned, then no permanent emission reductions would be realized. Temporary emission reductions will be realized to the extent that activities are postponed.

In order to address uncertainty in the emission reductions that will result from implementing this control measure, low and high estimates were made. It was assumed that an 80 to 90 percent compliance rate would occur during an advisory.

The estimates below show the range of emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

	RHC Reductions (Summer)		NOx Reductions (Summer)	
Year	Emiss. Reduced Low (TPD)	Emiss. Reduced High (TPD)	Emiss. Reduced Low (TPD)	Emiss. Reduced High (TPD)
1994	3.59	4.04	.10	.11
1997	3.68	4.14	.10	.12
2000	3.77	4.24	.11	.12

Costs of Control

As proposed, there would be no real identified costs to the affected industries. There will be costs to implement the measure both to the District and affected industries. The use of advanced electronic communication equipment (transmitter - receiver) will minimize costs. Industrial costs for overhead may be $2,000 per facility per year. District implementation costs would be $200,000 per year to be shared with a voluntary program. Costs would be for the overhead for plan review and notification equipment.

The cost-effectiveness of this control measure has not been quantified at this time.

Other Impacts

No adverse environmental impacts are anticipated as a result of this control measure.

References

Federal Register; Vol. 51, No. 63, April 2, 1986; Dispersion Techniques Implemented Before Enactment of the Clean Air Act Amendments of 1970.

Hess, P.F., Position Paper - Prohibitive Day Control Measures, BAAQMD, May 8, 1986.

BAY AREA
'91 CLEAN AIR PLAN

CONTROL MEASURE DESCRIPTIONS

H. MOTOR VEHICLES

CM# H1: SMOKING VEHICLE PROGRAM

Background

This control measure would reduce RHC and NOx emissions from on-road vehicles by establishing a citizen complaint program for smoking vehicles.

Regulatory History

The District currently does not have a specific public complaint program for smoking vehicles. The District had operated a vehicle patrol system, which was deactivated due to budget cutbacks. The program used uniformed District staff to pull over vehicles and cite violators for excessive emissions under the California Vehicle Code. The California Highway Patrol (CHP) currently has the authority to enforce visible emissions standards for vehicles, although the CHP's effectiveness in this area appears to be rather limited.

The South Coast AQMD currently has three smoking vehicle enforcement programs: (1) a public complaint program, (2) a SCAQMD-CHP vehicle patrol program and, (3) a smoking bus program.

Emissions Subject To Control

The affected source categories are tailpipe emissions for various types of on-road vehicles. Only a portion of the emissions in these categories (i.e. 2 percent) were assumed to be affected by this control measure. The projected RHC and NOx emissions subject to control are given below.

Year	Emissions Subject to Control RHC (TPD, Summer)	Emissions Subject to Control NOx (TPD, Summer)
1994	2.44	4.94
1997	2.00	4.42
2000	1.61	4.02

Proposed Method Of Control

In order to implement a smoking vehicle complaint program, the District would obtain and publicize a special toll-free phone number for smoking vehicle complaints. The telephone number for the South Coast AQMD's program is 1-800-CUT-SMOG. The District would develop a special report form to record vehicle complaint information. The program would be facilitated by a computer link-up with the Department of Motor Vehicles in order to verify the accuracy of information and obtain the smoking vehicle owner's name and address.

After sorting and verifying the complaint information for accuracy, the complaints would result in letters being sent to registered owners. Compliance would be voluntary, although enforcement action could be initiated by the District or through local law enforcement agencies when warranted, or as a phased in program where increased stringency was desired.

Emission Reductions Expected

It was assumed that the RHC and NOx emissions from affected vehicles would be reduced by an average of 3 to 6 percent, for a voluntary repair program, depending on vehicle type.

The estimates below show the emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	RHC Reductions (TPD, Summer)	NOx Reductions (TPD, Summer)
1994	.08	.20
1997	.07	.18
2000	.06	.17

Costs of Control

The costs of this control measure would largely be related to the costs of repairing or replacing smoking vehicles. It is expected that older vehicles, which are not subject to the Smog Check program, will be the most common offenders. The program would also require a minimum of four additional District staff.

The cost-effectiveness of this control measure has not been quantified at this time.

Other Impacts

Fuel economy could be improved for affected vehicles that are repaired to operate properly, leading to an overall reduction in the use of gasoline. Exposure of motorists to noxious fumes from smoking vehicles would be reduced.

References

South Coast AQMD, 1989 AQMP Revision, CM #88-G-5.

CM# H3: REQUIREMENT FOR CLEAN FUEL VEHICLES IN FLEETS

Background

This control measure would reduce RHC and NOx emissions by requiring certain fleet operators to purchase and operate cleaner vehicles, through use of alternative fuels and/or improved control systems which reduce emissions below prevailing standards.

Corporate fleets are believed to constitute around 10 percent of vehicle registrations in the Bay Area. A survey of the fleet operators in the South Coast Air Basin, showed the following general characteristics:

- 12 percent of the total vehicle population is owned by fleet operators.
- The average fleet vehicle is driven around 10,000 miles/year.
- 99.5 percent of fleets are non-transit.
- Public transit vehicles such as buses are driven over 34,000 miles/year.
- Fleets use 15 percent of the gasoline and, more significantly, 60 percent of the diesel fuel consumed in the South Coast District.
- A very small proportion of fleet operators (5 percent) operate a large percentage (70 percent) of fleet vehicles.
- Conversely, there are numerous fleet operators (60 percent) whose market share add up to a small percentage (6 percent) of all fleet vehicles.

Regulatory History

In September 1990, in response to California Clean Air Act requirements, the Air Resources Board (ARB) adopted emission standards for low and ultra-low emitting (LEVs). These standards will be implemented between 1994 and 2003 model years, and are expected to require the use of alternative fuels on some models. New gasoline specifications are also being implemented by ARB.

Senate Bill 2723, authored by assemblyman John Seymour and signed into law in 1988, appropriated funds from the Petroleum Violation Escrow Account (PVEA) to conduct a demonstration of compressed natural gas (CNG) as a transportation fuel. To carry out the demonstration, funding is provided to pay the cost difference between the price of new CNG-powered light duty vehicles and comparable gasoline powered vehicles when purchased by local governments.

Recent California legislations (SB 151) have authorized the SCAQMD to adopt regulations that require fleet operators to purchase and operate clean fuel vehicles. In particular, staff has been directed to proceed such that, by the year 2000, 15 to 30 percent of all fleet vehicles should be clean fuel vehicles.

Emissions Subject to Control

The affected source categories are tailpipe and evaporative emissions from *light duty passenger vehicles -- catalytic* and *light and medium duty trucks -- catalytic*. It was assumed that one percent of the total emissions from these categories would be affected by this control measure. The projected RHC and NOx emissions subject to control are given below.

Year	Emissions Subject to Control RHC (TPD, Summer)	Emissions Subject to Control NOx (TPD, Summer)
1994	1.24	.41
1997	1.09	.39
2000	.91	.38

Proposed Method of Control

This control measure is intended to increase the fleet share of LEVs to a significant level within a given time period. The types and sizes of vehicle fleets that would be affected, and the percentage of LEVs required in affected fleets, has yet to be established. Fleets are well suited to this control measure as they are most likely to use central filling stations, which may be needed where alternative fuels are used.

Several options are currently viable for providing vehicles with reduced emissions, including cleaner gasoline-fueled vehicles which rely on modified fuel parameters and/or advanced control systems, and alternative fueled vehicles. Among alternative fuels, methanol, compressed natural gas (CNG) and liquid petroleum gas (LPG - propane or butane) are of immediate interest. Electric vehicles (EVs) are in an advanced stage of development. The status of the various alternative-fueled vehicles are briefly described below.

Methanol

Engines capable of operating on methanol and various mixtures of gasoline and methanol have been under development since 1980. These are called Fuel Flexible Vehicles (FFVs) and have been in various demonstration programs since 1988.

Most recently, the California Energy Commission (CEC) started a demonstration program with California light-duty fleet operators. Their goal is to facilitate the placement of at least 5000 FFVs by 1993. Ford and General Motors will each be producing around 200 vehicles in 1991, increasing to 2000 to 2500 by 1993. The CEC has agreements with major oil companies such as ARCO, Chevron, Shell and Exxon to establish methanol fueling stations throughout California.

Detroit Diesels have manufactured methanol-powered engines for transit buses which have been in various demonstration programs in Denver, the South Coast, and in Marin County. However, most of the research and the demonstration programs are in the light-duty passenger vehicle category.

Exhaust emissions from vehicles operating on methanol fuel are lower in RHC and NOx than gasoline-fueled vehicles. Because methanol is less volatile than gasoline, evaporative RHC emissions are also reduced. Studies have indicated that methanol fueled vehicles can effectively lead to a reduction of ozone levels by an estimated 20-50 percent on a per-vehicle basis.

Compressed Natural Gas

The light and medium-duty trucks are currently the most likely candidates for conversion to CNG. Most of the conversion of the fleet is expected by retrofitting the vehicles to run on CNG as well as gasoline. A typical converted van carrying two CNG storage tanks would

have a range of 200 miles. CNG can also be used in buses and other heavy duty diesel engines.

General Motors announced in July 1990 that the company will produce 1000 CNG dedicated light-duty pickup trucks by May 1991. 500 of these will be sold in California through selected dealerships.

PG&E has opened two CNG filling stations in Concord and Richmond. Others will open in Hayward, San Jose and San Rafael.

The major constraints on CNG as a vehicle fuel are its conversion costs, and the refueling and storage requirements (CNG is stored at 2400-3000 psi).

Recent tests by CARB showed that reactive organics and carbon monoxide emitted from CNG vehicles are about half of that of a comparable gasoline vehicle. Nitrogen oxides are around 66 percent of that emitted from a gasoline-fueled vehicle.

Liquid Petroleum Gas (LPG)

LPG in vehicles has been shown to reduce criteria pollutants, compared with gasoline- and diesel-fueled vehicles. LPG is marketed as propane or butane. It differs from natural gas in that it is heavier than CNG and that it has a higher heating value. LPG is stored at about 150 psi. The use of CNG and LPG are reported to extend engine life and result in less maintenance, compared with the gasoline engine.

LPG emits markedly less carbon monoxide than gasoline, as well as fewer reactive organics. Evaporative emissions are negligible with LPG, as it is always stored in sealed tanks and unexposed to the atmosphere even during fueling. LPG contains negligible particulates and effectively no sulfides. Initial studies have shown than NOx emissions from LPG-fueled vehicles are similar to those from gasoline-fueled vehicles but lower than from diesel vehicles.

Electricity

The technology that provides the most significant emission reductions on a per/vehicle basis is that of electric vehicles (EVs), which operating on batteries. The technology is progressing to develop batteries which provide greater range and higher speeds. Chrysler is expecting to introduce a half-ton mini-van in 1991 with a top speed of 70 miles/hour and a driving range of 120 miles.

The use of electric vehicles reduce RHC and CO emissions by almost 100 percent, and NO_x by 65 percent or more depending on whether power is generated within or outside the basin. Power plant emissions can be controlled to very low levels when compared to vehicle emissions.

Emission Reductions Expected

Emission reductions would depend on the number of vehicles converted, the type of alternative fuel used and many other variables. It was assumed that the tailpipe RHC emissions would be reduced by 25 percent for passenger vehicles and by 48 percent for light and medium duty trucks. Evaporative RHC emissions from these vehicles were

assumed to be reduced by 100 percent. NOx emissions from light and medium duty trucks were assumed to be reduced by 33 percent.

The estimates below show the emission reductions achievable if the measure could be fully implemented in the corresponding year. The actual implementation schedule will be established in the final Clean Air Plan adopted by the District's Board of Directors.

Year	RHC Reductions (TPD, Summer)	NOx Reductions (TPD, Summer)
1994	.41	.14
1997	.37	.13
2000	.38	.13

Costs of Control

The costs of control are dependant on many factors, such as the price of alternative fuels and vehicles compared to conventional vehicles, maintenance and overhaul costs, and the costs of retrofitting. The overall cost-effectiveness of this control measure has not been quantified at this time.

Methanol

On the basis of mileage output, methanol is estimated to cost from $1.00 to $1.50 per gallon in the early 1990s. Firm FFV vehicle production cost figures are not available.

CNG

The cost of retrofitting vehicles to run on CNG has been estimated at $2,500 per vehicle. Considering the fuel and maintenance costs, the payback periods were analyzed to range from 2.5 to 6.1 years. Ford estimated that dedicated NGVs would cost up to $1000 more than a comparable gasoline vehicle. Other data indicates cost savings of $13 to $293 dollars per vehicle per year. The fuel costs in these data includes amortized costs of a refueling station and associated operating and maintenance, but does not include federal and state fuel taxes.

The capital cost for CNG dispensing equipment is estimated at $250,000 per station

According to a report from the American Gas Association, on a total operating cost per mile basis including conversion, compressor station and fuel costs, natural gas vehicles enjoy an 11 percent savings relative to gasoline.

LPG

Retrofit costs per vehicle have been reported in the range of $700 to $1700 for an average vehicle. Prices for LPG are very competitive with gasoline. Existing fleets operating on LPG have reported cost saving in the range of 20 to 55 percent continuously over the past 10 years, including the mile/gallon differential and dispensing costs. The average price for LPG ranges from $0.46 to $0.77 per gallon (including tax and delivery), depending on the quantity of fuel purchased.

The cost of an installed large single tank dispensing unit is in the range $40,000 to $75,000, excluding the cost of associated site work or special fire protection. The installed cost of a

small installed tank (500 to 2000 gallons) and dispenser would range from $5,000 to $15,000.

Electricity

Estimates from the Electric Vehicle Corporation show the life cycle costs for electric vans to be 29 to 35 percent greater than for conventional vans. For an electric van to be competitive with conventional vans, the in-service life of an EV needs to be 143,000 to 165,000 miles. This is considered to be realistic.

Other Impacts

Adverse impacts associated with the use of alternative fuels include unknown public health effects of exposure to methanol and its exhaust product, formaldehyde. With current technology, methanol-fueled vehicles emit relatively large amounts of formaldehyde, a potential carcinogen (estimated to be 2 to 5 times the emissions of gasoline powered vehicles). Formaldehyde emissions can, however, be substantially reduced by tailpipe catalytic controls.

Methanol's water solubility and lack of odor and taste could permit widespread pollution before a methanol spill is recognized. Methanol also burns with an invisible flame, making methanol flames more dangerous and difficult to fight.

It would be necessary to minimize leaks and losses of CNG during handling, as methane is 30 times more potent than CO_2 as a greenhouse gas.

Increased utilization of some alternative fuels can aid in reducing the U.S. dependency on imported petroleum fuel.

References

SCAQMD 1989 AQMP Revision, CM #88-G-4, Clean Fuel in New Fleet Vehicles.

California's Mobile Source Plan for Continued Progress Toward Attainment of the State and National Ambient Air Quality Standards -- 1990 Update, CARB, December 1990.